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HANDBOOK

OF

MEAT INSPECTION

BY

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VETERINARY EDITOR EXPERIMENT STATION RECORD

With an Introduction by

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AUTHOR'S PREFACE.

By the passage on June 3, 1900, of the Imperial Law concerning the inspection of meat and food animals, meat inspection is put upon a different legal basis than has existed heretofore. The new law, which crowns with fruition the endeavors which for several decades have been made toward the introduction of general meat inspection in the German Empire, contains stringent provisions concerning the organization of meat inspection and general directions concerning methods of procedure with various kinds of defective meat. Temporarily, however, the meat inspection law, except in two parts, has not yet gone into effect. And in working over the new edition of the book I was, therefore, able to restrict myself in the section on the legal foundation of meat inspection to the introduction of the new law, together with the commentaries from official sources, and in rendering judgment on meat anomalies I confined myself to the addition of the qualifications of the new law to the regulations which had previously been in force and which had been based upon the pure food law. Attention should be called to the fact that the conception of damaged meat which had become general before the decree of the pure food law, but which was rendered void by that law, has again acquired a qualified recognition by the meat inspection law of the German Empire. The material of meat inspection, the investigation of meat and rendering of judgment on meat will be discussed in the regulations for enforcing the law which at present rest with the Federal Council. In case an official publication of these regulations does not appear, I shall compile them as a supplement to my HANDBOOK OF MEAT INSPECTION and publish it separately.

Moreover, the contents of the book have been enlarged and elaborated according to the results of the literature of the subject

up to October 1, 1901. Especial attention has been given to a review of the subject of infectious diseases of fish and crustaceans. The number of figures has been increased by illustrations on the recognition of age in sheep by the teeth, on the recognition of sex in crustaceans, on the development of trichina, on myxosporidial diseases of fish and by an illustration of the refractometer. The latter is used in testing fat of different origin, and will, therefore, be adopted in laboratories of meat inspection. Despite the increase in the contents of the book, it has been possible by shortening less important parts to publish it in its previous size.

In conclusion, I would state that I am now in a position to fulfil my previous promise to publish a bibliography of the literature of meat inspection. This bibliography will appear in the near future.

OSTERTAG.

BERLIN, February, 1902.

TRANSLATOR'S PREFACE.

OSTERTAG'S "Handbuch der Fleischbeschau" is generally recognized as the most complete and authoritative treatise on meat inspection. No apology, therefore, is necessary for the present attempt to make this work more accessible to English-speaking meat inspectors and veterinarians. The translation was undertaken immediately after the appearance of the fourth German edition, but has been somewhat delayed on account of the pressure of other work.

A few footnotes have been added where it was deemed desirable, especially in connection with the controversial discussion of the trichina question. Certain sections on the less important German laws have been omitted and a few discussions have been condensed.

Dr. John R. Mohler, Chief of the Pathological Division of the Bureau of Animal Industry, in addition to the labor involved in reading the whole manuscript and making numerous suggestions, prepared the Introduction, dealing chiefly with the history and present status of meat inspection in America. It was felt that American meat inspection was inadequately treated in the text, and Dr. Mohler speaks with recognized authority on this subject.

Perhaps the most pleasant duty of the translator in connection with this work is the acknowledgment of the unusually excellent condition in which the publishers have furnished the proofs, and of their uniformly prompt and courteous attention to all matters which the translator has laid before them.

E. V. WILCOX.

WASHINGTON, D. C.,
April 7, 1904.

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INTRODUCTION

HISTORY AND PRESENT STATUS OF MEAT INSPECTION IN THE UNITED STATES

BY

JOHN R. MOHLER, V.M.D.

The problem connected with the procurement and maintenance of a wholesome and hygienic food supply for the people is unquestionably one of the most important subjects with which the sanitarian has to deal. Public health demands the purity of animal food products. The vast quantity of meat consumed in the United States, where this food-stuff is plentiful and comparatively low in price, renders it of essential importance that nothing but innocuous and nutritious meat products be placed upon the market. The amount of meat, *per capita*, used annually by various countries was computed by the British Government in 1890, when it was found that in the United States an average of 119.7 pounds was consumed by every inhabitant, a ratio surpassed only by Australia, where meats are more abundant and cheaper in value. To satisfy this domestic demand and to supply the foreign orders for meat, there has rapidly developed in our midst a business the value of whose products in 1900 was estimated at over $811,000,000, and which, among our immense industries, ranks third as to the aggregate worth of yearly exports. These facts, together with our knowledge—authentically established—of the communicability to man of many animal diseases, compel us to recognize the urgent demand for a hygienic meat supply—a supply that is clean, wholesome and absolutely free from disease.

The foreign sales of the meat packing industry at first included numerous varieties of meats and meat products, and by 1879 the export trade in American bacon alone, without mentioning other food-stuffs, had become well established, when the continental countries became alarmed, seemingly on account of the presence of

trichina in American hog products, and accordingly prohibitive measures against these meats were instituted. Italy was the first to promulgate these restrictions, and by 1881 Austria, Germany and France had likewise prohibited the importation of American pork or its products. American cattle met a similar rebuff at the instance of Great Britain in 1882, when regulations commonly called the "Slaughter Order" were instituted by the Order-in-Council of the Board of Agriculture, which compelled American cattle to be slaughtered at the port of entry. This prohibition of store cattle was caused, presumably, by the presence of contagious pleuro-pneumonia among the cattle in a few of the Eastern States and Illinois, but notwithstanding this disease was effectually eradicated from this country in 1892, and since that time not a single case has been found either in cattle imported into Great Britain from the United States or among our herds, the restrictive measures continue to be enforced and the stigma constituting the assumed reason for this embargo remains. While it is plainly evident to anyone who has given this subject the least consideration that these two alleged sanitary procedures of foreign governments were directly pointed at the meat and live stock industry of this country, and although the vast falling-off in the value of our exports in these lines was to those variously engaged therein a hardship which continued for a decade, nevertheless, these interdictions must be considered as the potent and exciting factors in securing legislation for the scientific inspection of meats for foreign and domestic use and incidentally in advancing the cause of veterinary science in the United States.

The exclusion of American pork products finally became intolerable, and in order to relieve the situation and regain an export market for these food-stuffs, Congress passed the act of August 30, 1890, providing for the inspection of salted pork and bacon. It was but natural to presume that with the passage of such a law providing for the certification of the pure and healthful character of American meats all restrictive measures against our export trade would be revoked. However, this initial act was not sufficiently comprehensive, referring chiefly to the manner in which the products were packed and their appearance immediately before shipment, without taking into consideration the condition at the time of slaughter of the animals producing these meats. For this reason the European countries failed to abolish their restrictions against American pork. The relief expected in consequence of this act was not, therefore, realized, and on March 3, 1891, Congress, recognizing the importance of protecting and fostering this export

industry, the value of which had reached the sum of $104,660,000 in 1881, and of acquiring and maintaining a pure and wholesome meat supply for our own people, passed a more effective act. This legislation authorized the issuance of regulations providing for the ante and post mortem examination of all cattle, sheep and hogs intended for export and interstate commerce, especially providing for post-mortem inspection of cattle the meat of which is designed for export; for a microscopic examination of all hogs for export in order that certificates could be issued setting forth their freedom from trichinosis; the condemnation of all diseased animals; the marking or stamping of all inspected carcasses and the labeling of food products made from such carcasses intended for export or interstate traffic.

The work connected with the enforcement of this act was placed under the care of the Bureau of Animal Industry, which had been established in 1884 for the purpose of collecting information concerning the nature, cause, treatment and prevention of diseases of animals and the publication of the best measures for the prevention and eradication of such diseases. These increased duties rendered it desirable that the various lines of work be divided, and accordingly, on April 1, 1891, the Bureau was organized into several divisions, one of which was designated the Meat Inspection Division, and, as its name implies, had, among other duties, special supervision of the inspection of meats for export and interstate commerce. Regulations were immediately adopted for the purpose of carrying into effect this act of Congress. A system of inspection was devised, a force of veterinarians and their assistants organized and the inspection of meats inaugurated within ten weeks from the passage of the act, or on May 12, 1891, at the abattoir of Eastman & Co., of New York City. Other abattoirs made application for inspection, and by the end of the first complete fiscal year, 1892, inspection had been granted to twenty-eight abattoirs in twelve different cities.

It will thus be observed that federal meat inspection has only a very recent history, but one of which our people and our profession can justly be proud.

The microscopic examination of pork for trichina was first established in Chicago, June 22, 1891, and likewise started in other cities before the end of that year. At first there was some hesitancy and scepticism among the packers as to the practical application of this microscopic examination without seriously retarding the business of the firms and causing vexatious and unnecessary delays, but

all doubts were shortly dispelled by the satisfactory performance of the work, and the problem was efficiently solved by the persistence and skill of the Chief of the Bureau of Animal Industry and the growing perception and ripening knowledge of his assistants. As a direct result of these microscopic examinations of pork products which were subjected to the keenest scrutiny of the attachés of European countries and favorably reported upon by them, the decree of September 3, 1891, was made by the German government after the Saratoga Convention which readmitted American pork that was officially certified as having been microscopically examined before shipment from the United States. Subsequently similar interdictions were removed by Italy, France, Denmark and Austria, and in consequence of this reëstablished confidence relative to the healthfulness and purity of the pork products of this country the export trade began at once to show decided and gratifying increase and to gradually expand and regain its former importance and value.

The beneficial and desirable results that would necessarily accrue in consequence of having the supervision and inspection of the Government meat inspectors to certify to the purity and soundness of the products of their abattoirs, soon appealed to and was quickly acted upon not only by the packers who sought to compete in foreign markets, but those doing strictly a local and interstate business. The proprietors of those abattoirs desiring inspection for their meat products are required to make written application to the Secretary of Agriculture, stating the kind and number of animals slaughtered and the destination of the products thereof, and to agree to such supervision of their business as may be demanded by the regulations of the Bureau. On conforming to such requirements the packing house is given a serial number by which it and the products thereof are thereafter known, and an inspector is placed in charge of the plant and furnished with a sufficient number of assistant inspectors, stock examiners or taggers to carry out the required inspection.

The extension of the work caused by the enforcement of the act of Congress can not be fully apreciated or comprehended without a knowledge relative to the importance and magnitude of the subject. The successful and speedy elaboration of many details which necessarily required much labor and consideration and the care and efficiency with which they were immediately enforced exceeded all expectations when the difficulties and obstacles—the inherent perplexities of the question—were considered. Moreover, this inspection was an innovation in sanitation in this country and was

of necessity carried out principally by inexperienced men who were chosen chiefly on the strength of their political influence rather than by the breadth of their veterinary knowledge.

The next epoch in the history of meat inspection is marked by the placing of all employees of the Bureau into the classified service by Presidential order. This took effect July 1, 1894, since which time all appointments to the force have been made only after the applicant has passed a rigid and highly satisfactory examination. By this means only the intelligent, competent and superior candidates are chosen from the eligible list by certification from the U. S. Civil Service Commission. Now that the merit system is in vogue, not only the *personnel* of the Bureau has been improved, as would be expected, but the harmony and discipline resulting therefrom is vastly better than is possible where political intrigue forms a basis of appointment, promotion and retention. The first requisite to be met by those aspiring to the position of meat inspector is to be a graduate of a recognized and reputable veterinary college and then to pass a rigid examination that destroys the ambition of a large percentage of applicants. After successfully meeting these requirements and receiving an appointment, his future service depends entirely upon the personal equation and would include the ability, integrity and discretion with which his onerous and multiple duties are performed.

Previous to 1894 the inspection consisted principally in the examination of beef for export and the microscopic examination of pork destined for continental Europe, but at this time, owing to an increased demand for official inspection of meats, a similar ante and post mortem examination was extended to hogs as had already been in operation from the beginning with cattle. In the following year calves and sheep were likewise subjected to inspection both before and after slaughter. As the inspection gradually increased and covered a larger number of animals, it became more and more important to obtain sufficient authority from Congress to dispose of the condemned carcasses, as the original act failed to grant power for the proper disposal of such products. The danger of allowing condemned meats to remain undestroyed is palpable when taken into consideration with the limited authority of the Federal Government regarding the use of such carcasses within the State. That it is highly unsatisfactory to the Bureau, as well as to the health of our people, to permit the packer to have absolute control over the final disposition of unwholesome meats, was readily appreciated, especially in view of the dearth of state and municipal sanitary

authorities vested with the power for properly disposing of these products. Consequently, Congress, by the enactment of March 2, 1895, granted full power to the Secretary of Agriculture to adopt such rules and regulations as would be necessary to prevent the use of condemned carcasses for export or interstate traffic, making it a misdemeanor punishable by a fine not exceeding $1,000 or imprisonment not exceeding one year, or by both fine and imprisonment, in the discretion of the court. The work was rapidly advancing as the inspectors became more thoroughly trained and experienced. New problems and duties were taken up as fast as the previous ones had been elucidated and controlled, and the progress made was highly gratifying. In keeping with this policy of steady conservative progress, the service was extended in 1895 by new legislation to include the interstate cattle inspection, and by 1897 not only all the beef and the greater part of pork and other meat products exported to Europe, but a large amount of meat intended for interstate commerce was inspected in accordance with the law.

In the appropriation act of 1898 provision is made for the same ante and post mortem inspection of horses and their products as had been previously enacted in regard to cattle, hogs and sheep. It is specially stated that only horses may be slaughtered in such packing houses and their various products must be distinctly labeled as being from these animals. Inspection has been granted thus far to but one abattoir, the products of which are mainly, if not entirely, shipped to Norway and Sweden.

The demand for microscopically examined pork increased rapidly, and in 1898, 120,272,590 pounds of this product were exported. A large number of skilled and competent microscopists were added to the inspection force, but the demand for microscopic examination was so great among the packers that the Bureau found difficulty in supplying the desired amount of microscopic inspection for hog products intended for export. The great increase in the demand for this inspection during 1898 and 1899 was ably and successfully met by the microscopic force, and they were rendering conscientious and efficient service when the country receiving the vast majority of our pork products instituted semi-prohibitive regulations which have diminished the exportation of this product in the last few years to a very large degree, until in 1903 it figured only 19,108,341 pounds.

By perfecting the system of inspection and increasing the number of inspectors, the work has been greatly extended and rendered more efficient each year, until to-day the scientific, systematic and rational system of meat inspection inaugurated throughout this

country by the Bureau of Animal Industry, after an existence of only twelve years, compares favorably with the much older service of Germany, France, Denmark and Belgium, and is pointed to with commendation by many disinterested parties in foreign countries and accepted as a model by our states and municipalities in providing methods of local inspection. How this result was accomplished has been ably expressed by a foreign scientist in speaking of the United States meat inspection service:

"The history of this organization embodied in the labor of Dr. D. E. Salmon is one of the highest examples of the rare combination of scientific methods with executive administration that has ever been witnessed." It may be added that among the many signal personal achievements of Dr. Salmon's administration as Chief of the Bureau of Animal Industry since its inauguration, his work in connection with meat inspection stands among the foremost, as he, and he alone, crystallized and consolidated it into a definite sanitary force. The initiative, the determination and the momentum in all matters pertaining to the advancement and increased proficiency of this service were his, and it has now reached such a stage of development and approach to uniformity of procedure as to meet the demand of the most critical.

Thus, commencing with a small force of inspectors in a few abattoirs, the service has gradually developed until at present there are 1,405 individuals engaged in the ante and post mortem inspection of animals. Of this number 411 are meat inspectors and assistant meat inspectors, all of whom are qualified and competent veterinarians; 234 are stock examiners and 251 taggers, practical men connected with some branch of the live stock industry before receiving their appointments; 233 are microscopists and assistant microscopists; and the remainder are clerks directly associated with the work of inspecting meats. These men are located in 156 abattoirs and stockyards in fifty different cities in the United States.

It may be of interest to know how this large organization of men is systematically working in the accomplishment of so much good for the country both from an economic and sanitary standpoint. A brief survey will be taken of the methods at the various abattoirs and stockyards of making the ante and post mortem examination of the food producing animals the products of which are intended for export or interstate traffic.

Ante-mortem examinations are made of all animals intended for slaughter in packing houses having federal inspection as well as of

those which pass through the stockyards that are under Government supervision. These inspections are highly important and a valuable safeguard to the health of the meat consumer, as there are certain diseases and conditions not attended by any macroscopic lesions in the carcass, albeit they are nocuous and repugnant. Direct proof of this is found in the literature of meat poisoning, the great majority of which cases could be directly traced to eating the meat of cattle slaughtered in emergency without any noticeable changes being observed in the tissues on post-mortem examination. The interests of the live stock industry also are protected by this examination, since none but healthy animals which have not been exposed to any disease are permitted to be shipped from stock yards to the farm as breeders and feeders or to abattoirs of other cities not having federal inspection. The rigorous character of this inspection before slaughter is indicated by the fact that ante-mortem condemnations average about twice as many as the post-mortem. In the larger packing centers this inspection is done in the yards, on the docks, though principally at the scales, where all diseased and suspected animals are tagged. A brief description of their condition is recorded and they are then held for final disposition on post-mortem examination, with the exception of those animals that have been condemned for advanced pregnancy or recent parturition. These animals may be held until they have fully recovered from the parturient state (ten days) and then slaughtered, or in case they are not affected with or have not been exposed to any infectious disease they may be sold for stock purposes.

Animals not inspected in the yards are subjected to an examination in the pens of the packing houses, and those condemned are similarly disposed of as above with the permission and under the supervision of the inspector.

Those that have been condemned on ante-mortem examination which fail on post-mortem to show sufficient lesions to warrant condemnation are passed for food, while all carcasses not fit for consumption are tanked. However, there are a number of diseases in which the determination of the healthfulness of the meat must depend entirely on the post-mortem examination, and many animals are condemned at this stage that have passed ante-mortem inspection. Thus the importance of these two associated methods of inspection is exemplified. The Bureau regulations which were devised to control the ante and post mortem inspection of animals and which have been subsequently supplemented as the needs of the service demanded, are clearly defined, thorough and most rigid

and form a support upon which the inspector may unflinchingly stand in the performance of the duties of his office. To discriminate with certainty between good and bad in the matter of meat supply is to the experienced inspector not a difficult task, when the carcass represented is an extreme, but for those cases on the border line, the rendering of a satisfactory and accurate conclusion is not so easy as at first sight appears, for it is extremely difficult at times to say what should be accepted and what rejected. To the German inspector it is not merely a question of yes or no, but with his "freibank" and the permission to sell certain infected meat after cooking, or raw meat of a low nutritious value, the responsibilities become divided into several possible actions and are thereby materially lessened. Owing to the impossibility of constructing rules covering every case, and the difficulty of asserting at what stage in its development a process assumes loathsome or a disease noxious properties, the decision as to the disposition of a certain number of carcasses must be left to the discernment and individual judgment of the inspector. Moreover, the realization that all decisions based upon the literal or tolerant interpretation of the inspection rules and in sympathy with them will be approved arouses a pleasant and appreciative feeling and makes the thorough and particular knowledge of the regulations an integral factor in the proper and independent performance of the inspection.

As there has been more or less discussion and adverse criticism regarding the large number of carcasses which the Federal inspector examines each day in some of the larger packing houses, it might not be out of place to explain the American system of perpetual motion adopted in such abattoirs and the methods which make it possible for the inspector and his assistants to carefully and efficiently inspect the entire killing. The method of slaughter most frequently adopted is stunning with a pole-axe, followed by bleeding after a short interval has elapsed to permit of relaxation of the blood vessels and, consequently, a better outflow of blood. In the case of bulls, shooting is sometimes adopted, owing to their thick skulls. The Jewish method of shechtering is carried on in certain abattoirs on specified days. In the first instance the cattle are driven up to the killing pens at 6.30 A.M., and knocking begins immediately. The animal is then shackled, hauled through the sliding door onto the bed, hoisted on the rails of a suspended tramway and, while hanging, is bled by the "sticker" making at the bottom of the jugular furrow a longitudinal incision that severs the principal cervical blood vessels. After the animal has bled suffi-

ciently it is pushed along by power or by hand to the bed on which it is to be further handled. While hanging here the "headers" skin the head and disarticulate it at the occipto-atloid articulation. The heads are numbered either by a paper tag or by marking on the occipital condyle with a blue pencil, in order to identify the various parts of the carcass, should cause for condemnation be found. The animal is now lowered and pritched in position on its back. A constant string of attendants follows, one after another, in completing the work and turning out the dressed carcass. First the "leggers" take charge and remove the hind legs at the hock and the fore legs at the knee. Immediately after this the floorsman or "sider" skins the animal down as far as he can work towards the floor. The "caul-puller" now comes along and makes an incision from throat to anus and removes the caul fat from the abdomen, placing it in a box corresponding to the number of the bed upon which the animal is lying. Another butcher follows and "loosens up" the esophagus and trachea and saws through the sternum. The hooks of the spreader on the hoist are then placed in the ligaments back of the hocks and the animal dragged into a semi-vertical position for skinning the buttocks and cutting off the tail. The latter is also retained and marked for recognition. After hoisting to a perpendicular position, the "backer" finishes skinning the animal. The "gutter," working simultaneously, eviscerates the carcass by starting with the rectum and following the sublumbar attachments down to the liver, pulling the paunch down and cutting all attachments with one circular sweep of the knife. The liver is next loosened by the hand and attachments cut by one stroke of the knife. Two circular incisions are made, starting from the superior and middle attachments of the diaphragm, but in opposite directions, following the tendinous portion of the diaphragm to its lowest or suprasternal portion. This opens up the thoracic cavity. The lungs are now seized by their subdorsal border and one long stroke following the aorta removes the lungs and heart, which, together with the other viscera, are now inspected. The rump sawyer next follows and divides the carcass from the coccyx to the lumbar vertebræ. The splitter with a large cleaver then continues splitting the animal in halves, ending at the base of the neck. The carcass is now hoisted on two rails with sliding pulley hooks and shoved over about twelve feet, where the neck man or hide dropper finishes cutting the hide from the neck, after which another helper splits the cervical vertebræ, thus completely separating the two halves. The latter are then pushed about ten feet

further, where the trimmers cut off all ragged pieces of flesh or bruised parts, trim out the spinal cord and pump the blood out of the four quarters by moving the fore legs up and down rapidly and scraping the blood clots from the vessels with the hollow of the hand. The carcass is now turned over to the washers, who scrub and wash it with very hot water, and finish by wiping it dry with towels. In case the inspection has not revealed any disease, the carcass is marked by placing a gelatinized label bearing the words "U. S. Inspected" and a serial number in indelible ink, which can not again make an imprint, in the region of the rump, flank, plate and shoulder of each half of the carcass. This mark signifies that the meat has been carefully inspected according to law and passed. Exceptions to this method of labeling healthy meat are made with those carcasses that are intended for the cutting room or are used for canning purposes in the same abattoir. Those carcasses to be shipped in sealed cars to another official abattoir for canning or other purposes are likewise not labeled nor stamped. After hanging for fifteen minutes the meat is run into the coolers to be ripened for local use, interstate trade or for export. The head, tail and caul are then removed to other parts of the building, the livers are placed in special boxes and the remaining viscera are thrown into a carrier to be removed. To perform this work requires about 50 butchers and from 40 to 45 men who wash and trim carcasses and 60 helpers to clean floors, move wagons, carry away offal and perform other miscellaneous work. In the above described manner, this force of men in an abattoir in this country may kill and dress between six and seven rounds of cattle in an hour, which means an average of 130 carcasses per hour on 18 or 20 beds. By the latter term is understood a portion of the killing floor opposite to each knocking pen on which the animal is bled, eviscerated and dressed. The 20 beds are arranged in a continuous series, the workmen starting on the first bed and going down to No. 20, by which time the No. 1 carcass has been hung up and out of way for the next "run." In abattoirs where 28 beds are in use, two gangs of butchers and two sets of inspectors are used to perform the work. The inspector takes his stand with the gutter and passes down the line at his elbow, watching, feeling and examining all suspicious indications. Surely such an inspection made by a man skilled in his line will enable him to find any lesion or condition which is sufficiently extensive or repulsive to warrant condemnation, and his ability to perform this task is no more remarkable nor startling than the accuracy, deftness, familiarity and speed which we expect of any other

skilful and experienced person in another vocation. When disease is observed in a carcass, a red tag bearing the words "Condemned meat" is immediately attached to it with a lead and wire seal. The head, tail and caul fat pertaining to it are secured and similarly marked with condemnation tags. After the carcass has been "halved," all portions of the body are placed in a special room of the building reserved for condemned meats to await a more leisurely and extensive examination by the inspector. The latter always has an assistant at hand, and while the one is away looking after the saving of the various parts of the diseased carcass, the other continues along with the gutter.

Calves and sheep are inspected both ante and post mortem under the same conditions and in practically the same manner as the animals already mentioned.

The principal conditions requiring condemnation are mentioned in the Bureau Regulations and include: Hog cholera, swine plague, anthrax, rabies, malignant epizootic catarrh, septicemia and pyemia, advanced form of scabies and actinomycosis, inflammation of the lungs, pleura, intestines or peritoneum, Texas fever, generalized or extensive tuberculosis, advanced pregnancy or recent parturition, any disease or injury causing pyrexia or otherwise rendering the flesh unwholesome; those organs or portions of carcasses which are badly bruised or affected with tuberculosis, actinomycosis, cancer, or other malignant tumors and abscesses, suppurating sores and tapeworm cysts; immature or unborn animals; those animals too emaciated and anemic to produce healthy meat; distemper, glanders and farcy, and other malignant disorders, acute inflammatory lameness and extensive fistula.

Other causes for condemnation occasionally met with are parasitic ictero-hematuria and caseous lymphadenitis of sheep, Hodgkin's disease or pseudo-leukemia, inflammation of the genito-urinary tract and hernias. Hogs affected with urticaria, tinea tonsurans, demodex folliculorum and erythema are usually passed after detaching and tanking the rind.

If an animal is found to be affected with any of the above conditions the carcass and organs belonging to it are tagged and removed as above mentioned to a room provided for this purpose, the key to which is only in possession of the inspector or his assistant. When these meats are to be destroyed they are placed, together with a certain amount of floor scrapings, intestinal contents and other filthy substances, in the offal or fertilizer tank, the top and bottom of which are sealed with copper wire and lead seals

by a federal inspector. Steam is immediately turned on and the meat is destroyed for food purposes under the supervision of this officer.

If only isolated muscles or portions of the carcass are to be destroyed as a result of unhealthful properties or repulsive appearances, the carcass is usually removed to the cooling room with the condemnation tag upon it, and when properly chilled the affected parts are detached and tanked while the condemnation tag on the remainder of the carcass is removed and the regular inspection label placed upon the various parts.

This condemnation of meat for human food does not necessarily imply that the animal producing the meat was diseased. Such action may have been due to various causes, as fatigue, asphyxiation, immaturity, parasitism not transmissible to man and other repugnant conditions, which, although they may not prevent the consumption of the meat with impunity, still are loathsome to the American people, who desire to eat only palatable meat of known quality. This is attested by the various laboratories in the country occasionally receiving specimens of tainted or discolored meats with letters from parties requesting advice concerning their wholesomeness. Such meat is always a source of serious apprehension to the American public, who do not care to eat meat, even if wholesome, should it present an offensive appearance, and this sentimental feeling is respected by the inspectors.

In making a post-mortem examination of hogs two systems of inspection are enforced. One method is for the smaller abattoirs where the number of hogs killed per hour is comparatively small. One inspector can readily examine all these carcasses from the position he assumes on the bench beside the workman who eviscerates them. The second method in vogue is where the killing numbers 300 to 500 per hour and consists of the inspector stationed as above together with a colleague who is placed beside the scraping bench for the purpose of examining the cervical lymph glands of every carcass after the header has cut behind the jaws. This inspection is principally to determine the presence of tubercular infection that might inadvertently pass by the second inspector on account of the lesions not being very prominent. Frequently it brings to light incipient cases which show the lesions only in the glands of this region. In case any alteration is observed or felt by the inspector, a previously devised mark, usually a cut on the right leg, is made, or a condemnation card attached by means of a hog ring and ringer, for the purpose of attracting the special attention of

his colleagues on the bench to this particular carcass. By this system of examination a thoroughly satisfactory and efficient inspection is obtained and readily accounts for the large number of hog carcasses per hour which it is possible to successfully examine in this country.

Some inexperienced persons have thought this must be a superficial inspection, their misgivings being due merely to the fact that one or two inspectors could examine such a large number of carcasses per hour; but such doubts have been quickly dispelled in those who have been sufficiently interested to make personal observations. Unlike the old method of individual slaughter in vogue in many foreign abattoirs, where the inspector must go to each animal which is slaughtered, bled, eviscerated and dressed by one or two butchers, the method of handling the carcasses in this country is according to the combination or division of labor system, and unfamiliarity with these methods may probably account for the incorrect views held by some regarding this inspection. Their style of slaughter is not conducive to the performance of such a vast amount of work as in this country, nor is their inspection force so well organized as in the United States. Thus at Mannheim, where one of the finest abattoirs in Germany exists, the method of killing a steer by the percussion mask requires more time than would be consumed in killing eight similar animals in one of our large abattoirs, and the number of cattle slaughtered there during the entire year of 1901 was 16,338, an amount which one of the larger abattoirs in this country will have to its credit within two weeks. In the German abattoir the inspector usually has his own laboratory and much of his time is occupied in preparing tissues and in the microscopical diagnosis of lesions upon which he may desire information. In the United States the time of the inspector is wholly occupied by making gross examinations and thereby he is enabled to inspect a much larger number of carcasses than if it was necessary for him to spend a portion of his time over microscopical or bacteriological study of suspected tissues. In case such an examination is necessary, the carcass is at once tagged and placed in the retaining room, specimens of the organs and affected tissues are expressed to the Chief of the Bureau for investigation, and if an exceptional case, the disposition of the carcass may be determined on obtaining the diagnosis. Lesions concerning which a confirmation of diagnosis is desired, or other information regarding their nature is requested, are likewise sent to Washington for examination.

In order to give an idea of how the slaughtering of swine is accomplished, it may be mentioned that the pigs having been driven to the killing pens, a chain is placed around the hind leg of one of the animals and attached to one of a series of constantly moving arms on a so-called Ferris wheel, which elevates the pig from the pen and places it on an inclined rail. The struggles of the animal carry it before the "sticker," who makes a small incision in the median line of the neck directed toward the thorax and severing the larger cervical blood vessels. When the animal dies, the body is placed in scalding water and then pulled through an automatic scraping machine where it is relieved of most of its hair. This scraping is completed by men along the scraping bench, after which the head is cut almost away from the body and the inspector examines the cervical lymph glands. The hog is then hung on the track of a suspended tramway by means of a pulley which is provided with a double hook and fastened to the gambrel stick. The carcass is here eviscerated and during this process carefully examined by the inspector, who is placed at such a point on the killing floor that all the eviscerating goes on directly in front of him and so near the body that he can examine with his hand any lesion his eye might detect. His position also commands a view of the run before reaching him and of the line after the carcasses have passed onward. Beside him is a table, upon which various organs are placed, and in those cases where lesions are apparent, these viscera are tagged and held, as are also the carcasses, for a more elaborate examination after the killing has ceased, when the proper disposition of those condemned is finally made. The healthy carcasses are then passed along the rail through the shower-bath and thence to the cooling room.

All packages, cans, boxes, kegs, tierces and other vessels containing meat products from the inspected carcasses are required to be labeled with the number of the official abattoir whence they originated and with the declaration that they were inspected according to law. When the chief inspector is perfectly satisfied in this regard and also that they are pure and healthful, he has all packages intended for shipment properly marked with the white meat inspection stamps bearing serial numbers. They are thereupon immediately cancelled and the product is ready for commerce.

In addition to the regular ante and post mortem inspection of hogs a microscopic examination for trichina is made of all swine the products of which are exported to those countries that demand this inspection as a prerequisite for the admission of such meats.

After the hog has passed an ante and post mortem examination the carcass is moved to the cooling room, where three samples of muscle are taken by one of the government employees from the prescapular region, the pillar of the diaphragm and from the psoas muscle. Where the liver or tongue is to be exported a sample of this organ is likewise taken for special examination. The specimens are placed in a small tin box, which contains a duplicate tag to the one fastened upon the carcass from which the samples were taken. The boxes are then carried to the microscopic room, where they are carefully examined by the microscopist and his assistants. Small portions of each of the three muscles are snipped off and prepared by mincing into three thin, evenly-distributed translucent mounts held together in a compressor. Each preparation is then examined separately under low magnification by placing it in a frame on a mechanical stage of a microscope. By means of a specially constructed stage this frame which holds the compressor is made to run up and down on two parallel grooves and by means of a saw-tooth arrangement at the bottom and top of the stage, the compressor is forced onward, with mechanical precision, so that each field overlaps another. Therefore, every portion of the preparation must necessarily be in the field at some time during the examination. No microscopist is permitted to examine more than eighty slides per day and the work performed is always subject to the re-examination of the one in charge of this work. In case living trichinæ or non-disintegrated dead trichinæ are found in the mounts, the sample is marked "C" and the carcass is taken from the cooling room and rendered into lard at a temperature not lower than 150° F. or turned into prepared meats by boiling until the interior is completely cooked. Those preparations in which degenerated or calcified trichinæ or trichinæ cysts or any substance which causes the least suspicion, owing to its similarity to the above, are marked "B," and the meat of the carcass is withheld from shipment to those countries that require microscopic inspection, although free to be used in other trade. When the microscopist has found an absence of trichina, trichina-like cysts or any suspicious bodies, the preparations are marked "A," and the carcasses represented are used for filling the orders of those governments demanding trichina-free pork. Before this microscopically examined meat is taken out of the cooler to be cut up, all the rejected carcasses must be withdrawn and placed by themselves to be treated as above mentioned. All other meats in the cutting room are put away and the tables, chutes, blocks and carriers cleared of all pork previously handled. The

cutting up of the meat is then begun under the supervision of a government official, after which it is placed in a cellar to be cured and stored prior to shipment as trichina-free products. No other meats are allowed in this cellar, which is securely locked and the key retained by one of the government employees, who keeps an exact list of all meats coming into and going from the cellar. When the microscopically inspected pork has been cured, smoked or otherwise prepared, it is packed in barrels, boxes or other packages upon which purple meat inspection stamps are placed in grooved spaces and covered with tin, to prevent them from being scraped off. A purple certificate of inspection is then issued by the inspector in charge, stating the name of the consignor, consignee, destination and description of the packages and the numbers of the purple stamps thereon. It will thus be observed that from the time when the samples of muscles are taken from the hogs for microscopic examination, until the meat is packed and stamped for export, the entire proceeding is under the active and vigilant supervision of a government employee.

The following tables taken from the report of the Chief of the Bureau of Animal Industry for 1903 show in a vivid and convenient form the development of federal meat inspection from its establishment to the present time and include the number of abattoirs and cities having inspection, the number of animals inspected, the amount of microscopically examined pork exported and the total cost of each ante-mortem examination.

NUMBER OF ESTABLISHMENTS AND CITIES WHERE INSPECTION WAS CONDUCTED
FISCAL YEARS 1891 TO 1903

FISCAL YEAR	NUMBER OF ESTABLISHMENTS	NUMBER OF CITIES	FISCAL YEAR	NUMBER OF ESTABLISHMENTS	NUMBER OF CITIES
1891	9	6	1898	135	35
1892	28	12	1899	139	42
1893	37	16	1900	149	46
1894	46	17	1901	157	52
1895	59	19	1902	155	50
1896	102	26	1903	156	50
1897	128	33			

The following shows the exports of pork to countries requiring certificates of microscopic inspection from 1892 to 1903 :

	Pounds		Pounds
1892	22,025,698	1898	120,110,356
1893	8,059,758	1899	108,858,149
1894	18,845,119	1900	55,809,626
1895	39,355,230	1901	35,942,402
1896	21,497,321	1902	33,681,229
1897	42,570,527	1903	19,108,341

The following shows the cost of each ante-mortem inspection from 1893 to 1902, inclusive:

	Cents		Cents
1893	4.75	1898	0.80
1894	1.75	1899	.88
1895	1.10	1900	.95
1896	.95	1901	1.01
1897	.91	1902	1.08

NUMBER OF ANIMALS INSPECTED AT SLAUGHTER FOR ABATTOIRS HAVING INSPECTION FISCAL YEARS 1891 TO 1903

FISCAL YEAR	CATTLE	CALVES	SHEEP	HOGS	HORSES	TOTAL
1891	83,889	—	—	—	—	83,889
1892	3,167,000	59,089	583,361	—	—	3,809,459
1893	3,922,079	92,947	870,512	—	—	4,885,538
1894	3,861,594	96,333	1,020,764	7,618,146	—	12,626,835
1895	3,704,042	116,093	1,428,601	13,616,539	—	18,868,275
1896	3,985,484	256,905	4,629,796	14,250,191	—	23,122,376
1897	4,242,216	273,124	5,209,161	16,808,771	—	26,533,272
1898	4,418,738	244,330	5,496,904	20,893,199	—	31,053,171
1899	4,382,020	246,184	5,602,096	23,836,943	3,332	34,071,575
1900	4,841,166	315,693	6,119,886	23,339,884	4,559	34,619,188
1901	5,219,149	413,830	6,639,212	24,642,753	1,992	36,916,936
1902	5,559,969	555,836	7,434,878	25,277,107	1,649	38,829,439
1903	6,134,410	668,855	8,585,960	21,793,738	344	37,183,307

The subject of meat inspection thus far considered has dealt only with the Federal system, as this is freely conceded to be the highest type of rational inspection existing in the United States and the regulations controlling it are frequently drawn upon in inaugurating local inspections. The other forms found in this country are the local or municipal inspection and the state inspection. Before the act creating a system of meat inspection under Federal supervision was adopted, several states—as Indiana, Minnesota, Colorado, etc.—had so-called meat inspection laws, although they principally provided for an inspection of the living animals in the

stockyards. Certain cities, such as Boston, Detroit, Washington, etc., likewise inaugurated more or less valuable laws pertaining to a pure meat supply, but it was not until after the enforcement of the Federal act on this subject that more comprehensive and efficient municipal and state inspection laws began to appear, and, what is better, were enforced, encouraged as they were by the intelligent and successful work performed by the Bureau of Animal Industry. Among the most estimable of these laws for municipalities will be found those governing the meat supply of New Orleans, La., and Montgomery, Ala., which provide for public slaughter under the supervision of meat inspectors connected with the Board of Health, and every piece of meat inspected and put on the market must bear the official inspection stamp. The recent law passed by the Montana legislature must be considered as an excellent type of what each state should adopt and then honestly and efficiently enforce. By this broad and lucid law every city in the state having a population of 5,000 or over is required to have a system of meat inspection under the direction of a competent sanitary officer who must be a graduate of a recognized veterinary college.

The necessity for state and municipal inspection may be appreciated when it is understood that the government has no power to inspect meats that do not leave the confines of the state. The facts are, however, that in localities where abattoirs have federal inspection, much of the meat used for city trade or for shipment within the state as well as the large majority of the products which enter the interstate commerce is inspected by the government. But meat inspected may become contaminated, be subjected to unsanitary conditions, or become putrid or repulsive from various causes after it has passed beyond the jurisdiction of the federal inspector. It is therefore important that municipal and state inspection laws be on the statutes to take cognizance of such unhygienic conditions or changes in the flesh and to require market inspection in addition to ante and post mortem examination. However, the great danger that menaces the public health arises not so much from meat contaminated after inspection as from uninspected meat produced in the numerous unclean and ill-smelling private slaughterhouses so frequently found on the outskirts of a number of our cities. To control the latter and to control them efficiently it is essential that laws be enacted for the proper supervision of these establishments, which kill at all hours of the day and night as inclination dictates or necessity demands. The regulations thereof should insist that the viscera and their lymphatic glands must be retained after their

removal from the carcass until examined by the inspector and their connection with the carcass appropriately noted. Inspection that includes merely the dressed carcass is unworthy of the name and extremely delusive, as it gives a false impression of security to the consumer. These houses should also be compelled to kill only on certain days or hours in order to permit the inspector to be present. All the butchers should be licensed and likewise their abattoirs, which should come up to a certain prescribed standard. A far better law, and one which would receive the endorsement of all sanitarians, would ordain the abolition of these small buildings and the establishment of a public slaughterhouse, as in Montgomery, Ala., remote from the center of the city and its business section and where a thorough inspection by a veterinarian could be made of all animals. Such an abattoir under rigid, though rational restrictions, would be beneficial not only in facilitating the business but in promoting the sanitary interests of the city, as all the offal could be disposed of at once and all portions of the carcass not edible could be reduced to inoffensive articles of commerce.

In some cities where the inspection is enforced by laymen, such as butchers, cattlemen, or men even more disconnected with the practical part of the work, the result is seriously handicapped on account of their inability to recognize lesions that at once would appeal to one trained in the anatomy, physiology and pathology of the domesticated animals and in the relationship existing between their diseases and human health. If an adequate reason for municipal inspection exists, and no one of intelligence will deny it, this should possess equal strength for having the law intelligently and efficiently enforced by capable officers of the law, trained in the knowledge of sanitation and comparative medicine. The plea that such men are not available is becoming more untenable every day, as meat inspection has made such rapid progress and has now reached such an important position that all the leading veterinary colleges in this country have provided this chair and have filled it with experienced veterinarians who in many cases give practical abattoir demonstrations. It is only a question of time when every town and city of any size will arise from their sanitary lethargy, as a direct result of the education of public opinion along this line, and will have an organized and compulsory system of municipal inspection supervised by one skilled in veterinary science. And the adoption as well as the success of such inspection will depend to a great extent upon the interest shown and the support given it by the people of the country, for whose health and

well-being the conscientious inspector will give his constant surveillance.

Perhaps of all parts of the field of veterinary publication in English there is none so poorly supplied as that which pertains to practical meat inspection. The English literature on this subject has been very sparse and not of a highly valuable character, making it all the more difficult for an inspector without the knowledge of a foreign language to fully comprehend the nature of many of the uncommon pathological specimens with which he comes in contact during his inspection. Fortunate, indeed, was the German-reading inspector who had access to the monthly meat-inspection journal published by Ostertag, as well as the latter's Handbook. In that journal many of the lesions which are little understood are discussed and it is not infrequent that by such articles the resemblance of such processes to our own observed lesions may become apparent.

The issuance of the present publication on meat inspection, so ably translated from the masterpiece on this subject, will be of untold benefit, not only to the practical meat inspector and practising veterinarian, but to the professor, student and layman as well. The need of such a book has long been felt by the English-reading inspectors and will readily be appreciated by them. The translation will perhaps be particularly welcome on account of the unusual interest at present manifested in meat inspection in this country and the consequent demand for well-trained meat inspectors who can take charge of this work in various municipalities where meat inspection is being established.

I.

GENERAL DISCUSSION OF MEAT INSPECTION.

1.—Nature and Problems of Meat Inspection.

Nature.—By the term meat inspection is understood the professional investigation and judgment on the entrails and meat of slaughtered animals with reference to their fitness as human food. In a broader sense, meat inspection also includes the examination of living animals before slaughter, which examination is required for a more accurate judgment on the fitness of the meat for consumption. Furthermore, meat inspection embraces the supervision of public and private meat markets, as well as of all industries in which meat is manufactured into sausages and other products. This control of the market and industrial occupations, which in the older south German ordinances on meat inspection was characterized as extraordinary meat inspection, is a necessary supplement to true, or ordinary, meat inspection. For the meat of healthy animals which, in and of itself, is suitable for consumption, may, in consequence of improper preservation or other treatment, become subsequently unfit for consumption by man.

Problems of Meat Inspection.—1. The chief purpose of meat inspection is to protect man against the dangers which threaten him from eating meat. These dangers are of several sorts. The most serious consist in the possibility of the transmission of animal parasites (trichina and tape worms), as well as of infectious and toxic diseases (tuberculosis, glanders, anthrax, rabies, septicemia, pyemia, meat poisoning and botulism.

The sanitary supervision of the traffic in meat is one of the most important parts of public hygiene, since meat forms the almost daily food of the greater portion of human beings, and

consumers in the majority of cases are not in a position to recognize the wholesome or dangerous character of the meat of which they partake as food.

Meat may possess the freshest appearance, the red color, the firm consistency or fat content, and the peculiar odor—in short, all the characteristics of perfectly normal meat—and yet be unwholesome. The dictum of the English statesman Disraeli, "sanitary education is better than sanitary legislation," does not apply to the consumption of meat by man. Reliable criteria for the differentiation of wholesome and unwholesome meat are furnished only by the inspection of food animals before slaughter and the investigation of all parts of animals after slaughter, by meat inspectors. Thus it happens that there is no definite method of preparation by which all the unwholsomeness attaching to meat under certain circumstances may be removed. The consumer, therefore, can not protect himself sufficiently by private measures. Furthermore, experience has shown that the public, even in those cases in which it is possible, by observing certain precautions, to avoid the harmful effects of eating meat, is inclined to neglect these precautions. This is best illustrated by trichinosis. This is preventable by private measures,—thorough boiling or roasting of the meat. Nevertheless, the numerous epidemics of trichinosis to which hundreds of persons have fallen victims, have not sufficed to change the custom of eating raw and half-cooked pork. Gerlach justly observes that there is no more convincing proof of the everlasting unreasonableness of man in certain things than that furnished in trichinosis.

For these reasons it is to be considered the plain duty of every community, through the organization of meat inspection, to withhold from consumption all meat which is likely to injure the health of the consumer.

Meat as Food Material for Man.—Man is omnivorous. No human race is found which lives exclusively upon a vegetable diet. While in certain countries the meat of domesticated animals is not eaten, yet animal food is, nevertheless, consumed in the form of fish, amphibia, mollusks, etc.* The amount of meat which

* In Japan, according to Janson, the consumption of the meat of domesticated animals was forbidden after the introduction of Buddhism in the seventh century A.D. The slaughter of animals was resumed after the admission of foreigners to the country. At first the latter alone ate meat. Gradually, however, the Japanese accustomed themselves to animal food, and in the beginning of the 80's it was introduced into the Japanese army.

is eaten depends essentially upon the climate in which man lives. While the inhabitants of the tropics live principally on a vegetable diet and those of the polar regions almost exclusively upon an animal diet, the inhabitants of the temperate zone live upon a mixture of both food materials, as the most suitable nourishment. The vegetarian manner of life in our latitude must be characterized as founded on error. The case is not altered by the fact that certain individuals, in spite of abstaining from meat, are capable of exerting considerable energy. Meat is indispensable for the majority of human beings if they are to remain capable of a normal amount of work. According to Manfredi, the physical degeneration, lack of energy, and effeminate habits of the southern Italians are due to the fact that they eat so little meat. Furthermore, according to Alanus, the so-called atheromatous degeneration of the walls of the blood vessels is frequently observed in vegetarians.

Consumption of Meat.—According to the reports of the German abbatoirs, the consumption of meat in cities amounts to from 50 to 90 kg. per capita per annum, exclusive of game, fowls and fish. In country districts the use of meat is less extensive, so that the total consumption in cities and in rural districts averages considerably lower. In the Grand Duchy of Baden, which thus far has furnished the only reliable statistics on this point, the consumption of meat in 1890 amounted to 35.4 kg., and in 1894 to 42.1 kg. The consumption of meat varies with the market price.

The Bureau of Statistics in England published a statement in 1890 on the consumption of meat in various civilized countries. According to this statement, the following amounts were consumed per capita per annum:

Australia	111.6 kg.
United States	54.4 "
Great Britain	47.6 "
Sweden and Norway	39.5 "
France	33.6 "
Germany	31.6 "
Belgium and the Netherlands	31.3 "
Austria-Hungary	29.0 "
Russia	21.8 "
Spain	22.2 "
Italy	10.4 "

Lichtenfelt compiled statistics for the year 1894 on the consumption of meat in Germany and the relative importance of the different kinds of meat in different parts of Germany:

PER CAPITA CONSUMPTION OF MEAT IN GERMANY.

Region	Cattle	Calves	Sheep	Hogs	Total
	Kg.	Kg.	Kg.	Kg.	Kg.
Prussia	17.6	1.2	2.8	15.7	37.3
Brandenburg	11.4	2.2	2.3	21.9	37.8
Pomerania	13.4	2 0	4 3	20.7	40.4
Posen	14.4	1.7	2.4	21.2	39.7
Silesia	13.0	2 3	0 9	16.6	32 8
Saxony	11.1	2.3	1.4	25.0	39.8
Schleswig-Holstein	20 5	2.6	1 8	23.4	48.3
Hanover	10 9	1.7	1.3	21 6	35 5
Westphalia	11 5	2.3	0.4	19.2	33.4
Hessen-Nassau	19.5	1.4	1.2	19.7	41.8
Rheinland	18.6	1.7	0.5	16.8	37.6
Bavaria	20.2	3 9	1.0	24 5	49.6
Kingdom of Saxony	11 6	2 6	0.9	17.3	32.4
Wurtemburg	14 5	1 1	0 6	23.3	39 5
Baden	22 7	3.0	0 5	30 8	57.0
Alsace-Lorraine	13.6	2.6	1.3	15.9	33.4
Average	15.3	2.2	1 5	20.9	39 9

More than the average amount of meat, therefore, is eaten in Pomerania, Schleswig-Holstein, Hessen-Nassau, Bavaria and Baden. Baden and Bavaria are especially conspicuous in this respect. The smallest quantity of meat is eaten in Silesia and the Kingdom of Saxony. Beef is consumed to the greatest extent in Baden, and least in Hanover; veal, to the greatest extent in Bavaria and least in Wurtemburg. The inhabitants of Pomerania eat the most mutton, while those of Westphalia, Rhineland and Baden consume the least. The contrast with reference to the consumption of pork is quite striking, for, while the greatest quantity is eaten in Baden, the neighboring inhabitants of Alsace-Lorraine consume almost the smallest quantity of pork.

Meat Rations in the German Army.—The small peace ration of the German soldier includes, in addition to bread, rice, legumes or potatoes, and hulled barley, 150 gm. of meat; the large peace ration during the maneuvers, 250 gm.; small war ration, 375 gm.; and the large war ration, 500 gm.

2. Another problem of meat inspection consists in protecting consumers from financial loss by fraud. The inspection of meat must secure the proper conduct of the meat traffic. It protects

meat buyers against the likelihood of paying full price for inferior food stuffs. As Schmidt-Mülheim rightly observes, no food material lends itself so readily to adulteration and fraudulent treatment as meat. Where meat inspection is not regulated, it is a well known daily occurrence that meat of the lowest market value is offered for sale at full prices. It not only happens that unscrupulous dealers substitute horse meat for beef, but an extensive fraudulent traffic is carried on with the meat of diseased animals. Butchers obtain the meat of such animals at minimum prices and sell it to unsuspecting buyers at full market price. In so far as the meat of diseased animals is not dangerous to human health, its sale may be permitted, but it is no more than right that the consumer should be made acquainted with the facts, and that he should be able to take advantage of the lower market value due to the diseased condition of the animal.*

The Value of Meat Inspection for Agriculture.—The profit which butchers make through the unrestricted sale of the meat of diseased animals is very considerable, since diseased animals are sold by farmers at ridiculous prices. Forty to fifty marks is a high price for a diseased beef animal, as appears from numerous legal proceedings in cases of violation of the pure food law. For example, one butcher bought a diseased beef animal for 11 marks and testified that he had bought cattle at cheaper prices.

Such methods of taking advantage of the rural population are checked by active meat inspection. A certain proportion of diseased animals is indeed prohibited from sale, but the owners are protected against punishment, the degree of severity of which is quite out of proportion to the small profit which may be made from the unrestricted sale of questionable material. The other, and, as experience shows, by far the greater proportion of diseased animals, the farmer is permitted to retain and utilize to advantage in a legitimate manner. Thus, for example, in the Grand Duchy of Baden in 1891-1892, only 1,588 out of 12,200 cases of emergency slaughter were prohibited from sale, while the remainder were utilized at reasonable prices.

For this reason meat inspection is of advantage to agriculture, and it is an evidence of failure to recognize the facts in the case,

* The substitution of inferior in the place of prime meat is an old practice of meat dealers, as appears from the old records concerning meat inspection. In this connection the procedure of the magistrate in Passau in the fourteenth century is noteworthy. The butchers were compelled to take oath annually that they would sell only healthy marketable meat.

that, formerly, farmers in various countries opposed the introduction of meat inspection. Thus it also comes about that in countries without meat inspection the farmer is in other respects at the mercy of the butchers. It is sufficiently apparent from legal proceedings that butchers have sought to secure a great reduction in price on account of slight defects which were discovered after slaughter, while at the same time they offered the whole animals for sale to the original owners who lived some distance away. Thus, certain cattle dealers were convicted of fraud in twelve cases in which they had pretended to the farmers that the cattle which they had bought of them had been found to be diseased when slaughtered. Such business methods are rendered impossible by the regulation of meat inspection. To the credit of the butcher's profession, however, it should be mentioned that the corporation representatives of butchers in Germany repeatedly appeared before the Reichregierung in the interests of the introduction of meat inspection.

3. It is the function of meat inspection to furnish valuable assistance to the veterinary police and to veterinary hygiene. Through the regular investigation of numerous animals, especially through the opportunity to determine the condition of the internal organs of such animals, meat inspection is in a position to detect cases of animal plagues which escape the notice of veterinary police. The detection of glanders offers, perhaps, the best proof of this statement. Moreover, the reduction in the number of cases of pleuro-pneumonia and the systematic warfare waged by veterinary police against tuberculosis is made possible only on the basis of a regulated meat inspection. The value of meat inspection for veterinary police appears in recent times to be underestimated. The words of Gerlach should, therefore, be borne in mind, that the successful labor of veterinary police is absolutely impossible in the present business operations without the control of the slaughter of animals.

The Detection of Epizootic Outbreaks by Meat Inspection.—In the years 1892 to 1895, aside from foot-and-mouth disease and swine plague, there were detected by meat inspection in Germany 168 cases of anthrax, 54 cases of glanders, 28 cases of pleuro-pneumonia, 10 cases of horse mange, and 55 cases of sheep scab. From 1896 to 1899, 212 cases of anthrax (including black-leg and hemorrhagic septicemia), 96 of glanders, 26 of pleuro-pneumonia, 11 of horse mange, and 54 of sheep scab were detected. In this

connection it should be remembered that the official statistics do not enumerate all cases of the detection of infectious diseases by meat inspection.

In the abattoir at Magdeburg, during the first year for which reports were made (1892-1893), 11 cases of pleuro-pneumonia were found in apparently healthy cattle, and thus many affected localities were discovered and brought to the attention of the veterinary police. In the Province of Posen, during the last outbreak of pleuro-pneumonia, the rapid reduction in the number of cases of this disease was due to the fact that the first case, which was brought to slaughter, was detected in an abattoir, thanks to meat inspection, which had been introduced in that locality.

The purpose of veterinary hygiene is furthered by meat inspection, since all virulent material capable of multiplication found in slaughtered animals, especially animal parasites and their larval stages, is rendered harmless. Meat inspection is one of the most efficient means of combating the ever-increasing infection of domesticated animals by worms and bacterial diseases, and it thereby increases the profits from agriculture.*

In localities without meat inspection, animal parasites, which annually cause an incalculable loss to agriculture, are furnished favorable conditions for propagation. The organs which contain parasites are not destroyed, as happens where meat inspection is regularly performed, but are usually fed to such animals as are capable of spreading the disease. In this regard meat inspection has already achieved visible results. In consequence of the systematic inspection of hogs for cysticerci, the tape-worm of man (*Taenia solium*), which develops from the hog bladder-worm, has become one of the greatest rarities in Germany. The number of measly hogs among native animals has been correspondingly reduced. In contrast to this state of affairs, it has been shown in the case of hogs which came from countries without meat inspection (Galicia, Roumania, Servia and Russia), that the percentage of infected animals is incomparably higher. As in the case of measles in hogs, so also in measles of cattle, echinococcus diseases and other parasitic affections; in fact, even in the proportion of the infectious diseases of domesticated animals, the same result will be brought about. With regard to infectious diseases, the favorable effect of meat inspection is to be expected, especially in the case of tuberculosis of domesticated animals—our greatest

* By this means also meat inspection is of considerable benefit to agriculture.

plague. By the careful destruction of tuberculous organs, the dissemination of the pathogenic organism and the possibility of its transmission to other animals are prevented. The disastrous consequences of carelessness in handling tuberculous organs and parts are shown by an occurrence in the abattoir at Copenhagen. For a long time the butchers were allowed to feed hogs with the refuse from the abattoir. On slaughtering these animals it was found that 80 per cent. were tuberculous.

Statistics on Entozoa and Meat Inspection.—Statistics on the occurrence of various entozoa which are communicable from man to animals furnish abundant proof of the beneficial effects of meat inspection. Wherever meat inspection has been introduced, *Taenia solium* of man, which develops from the hog cysticercus, has become of rare occurrence. Thus, in Southern Germany, *Taenia solium* of man and *Cysticercus cellulosae* of the hog have become rare in consequence of the existence there for a long time of regular meat inspection. In Munich, *Taenia solium* is almost never observed. Bollinger, therefore, made use of the frequency of the occurrence of *T. solium* of man as a test of the quality of meat inspection. In striking contrast to *T. solium*, *T. saginata* has constantly increased in the last twenty years, because the early stage of this tape-worm in cattle, partly on account of the non-existence of meat inspection and partly on account of an insufficient examination of cattle for this cysticercus, was, up to within a few years, only occasionally discovered.

The cysticercus disease of man has decreased to a degree which corresponds with the rare occurrence of *T. solium*. Next to Saxony and Thüringen, Berlin has furnished the largest number of cases of the cysticercus disease of the eye for a number of years. The oculist Hirschberg, for example, observed 70 cases of cysticercus of the eye among 60,000 cases of eye disease in the sixteen years between 1869 and 1885. From 1886 to 1892, on the other hand, in 46,000 cases of eye disease, Hirschberg found only two cases of cysticercus, one of which came from Saxony. This can not be accidental, but must be considered as a consequence of the introduction of meat inspection, which took place in Berlin in 1883. From 1892 to 1893, Hirschberg observed no case of cysticercus of the eye in Berlin, but observed one from Westphalia and one from Saxony.

Virchow also observed a less striking, but still noticeable, decrease in cysticerci in comparing post mortem findings from 1875 to 1891. Of the 126 larvæ of *T. solium* which were found in

cadavers during this time, 101 were located in the brain. When we compare the number of cysticerci found in the brain with the total number of brain examinations, it appears that since the introduction of meat inspection the ratio has diminished from 1:31 to 1:280.

Of 14,000 cadavers in Munich which were examined in the Pathological Institute of that city up to the beginning of the 80's, only two cysticerci were found in the brain, while in Berlin this parasite was found in 87 of the 5,300 post mortem examinations up to the year 1877.

The decrease in the echinococcus disease of man is also striking. Up to the year 1888 Virchow was able to demonstrate from 5 to 9 cases of echinococcus disease per year in the cadavers which were examined in the Pathological Institute at Berlin. After 1888, however, the number of cases decreased to from 3 to 1.

Deffke has called attention to the inter-relation between meat inspection and helminthiasis of dogs. According to his investigations, the number of dogs infested with entozoa in Berlin has diminished considerably since compulsory meat inspection was introduced into that city. While entozoa were found in nearly all dogs in Island, in Berlin at the end of the 80's only 62 per cent. were infested. Deffke attributes this difference chiefly to the rare occurrence of the three large taeniæ of dogs, especially *T. marginata* (from the *Cysticercus tenuicollis* which occurs so frequently in food animals). Krabbe found *T. marginata* in Island in 75 per cent. of the dogs; Schöne, in Saxony, in 27 per cent.; Deffke, in Berlin, in only 7 per cent. Before the introduction of meat inspection, the large taeniæ of the dog in Berlin, as was shown by special reports and statistics of disease, were a very frequent subject of treatment. According to Deffke, it may be asserted with tolerable certainty that in Berlin the tape-worms of the dog have become less frequent, entirely on account of the well regulated meat inspection of that city.

2.—History.*

Antiquity.—Traditions of the oldest civilized nations show they possessed certain regulations concerning the consumption

* Compare the works of Gräber, "Historical Account of the Development of Public Sanitation in the Field of Animal Foods"; Goltz, "The History of Animal Foods and Meat Inspection," also "Historical Studies in the Field of Meat Foods and Meat Inspection"; Adler, "Public Valuation of Meat in German Cities at the Close of the Middle Ages"; and the related articles of Morot, Pütz, Stumpf and Gehrke.

of meat. Thus we learn through Herodotus and Plutarch that the Egyptians were forbidden to eat pork for the reason that it produced an excess of humors and eruptions. The animals which served as offerings to the gods and as food for the priests had to be carefully inspected. Only the meat of "clean" animals could be used in offerings and eaten. The use of "unclean" meat, on the other hand, was forbidden. Moreover, sacrificial animals were required to be perfectly healthy and free from defect. Such animals were certified by a mark on the horns (a strip of paper sealed with clay). Death punishment was prescribed for priests who slaughtered an animal which was not certified in this manner. The meat of cows was not eaten by the Egyptians, since the cow was the sacred animal of Isis. Likewise, the meat of other animals which were considered sacred was forbidden food. Among the Egyptians the hog was the most unclean of all animals. Even accidental contact with it made one unclean, and led to exclusion from the temple until purification.

Moses commanded the Israelites to eat no fat and no blood and to avoid the meat of hogs. Concerning sacrificial animals, it is stated in Leviticus, Ch. xxii, v. 22: "Blind, or broken, or maimed, or having a wen, or scurvy, or scabbed, ye shall not offer these unto the Lord." Furthermore, "unwholsome meat, carrion, and anything which has defects shall not be slaughtered, and that which remains of sacrificed animals after the third day shall be burned with fire." Animals which were torn by other animals were regarded the same as carrion. The meat of animals which were affected with wasting diseases could not be eaten. The eating of blood was forbidden because Moses considered the blood as the seat of life which belonged to the Creator from whom all life originated. By offering the blood of animals, believers reconciled their souls with God. The High Priest purified himself in order to enter the holy of holies once a year. The eating of fat was forbidden because, like blood, it was intended for sacrifice. According to Tacitus, the consumption of pork was forbidden to the Israelites, not only from religious grounds, but also because the origin of "lepra Arabum" was ascribed to it. The animals which were permitted to be used as food included all of the ruminant ungulates, all fish which bear fins and scales, and birds which do not feed on carrion. Eating the meat of young animals was forbidden. A legal regulation was directed against the slaughter of such animals: "When an ox, or a lamb, or a goat is born, it shall be with its dam for seven days and thereafter it

may be offered to the Lord." The Mosaic, like the Egyptian, laws distinguished between "clean" and "unclean" food animals.

The Jewish method of slaughtering food animals was not prescribed first by the Mosaic laws, but by the Talmud, which was edited by learned Jews during the first five years of the Christian era.

The Phœnicians, like the Egyptians, abstained from eating the meat of cows and hogs, but held the meat of dogs in high esteem. Berosus relates from the books of Oannes that the Babylonians established detailed regulations concerning diet.

In Athens in the earliest times there was established a system of market police, whose officers (agoranomoi) were intrusted with the proper conduct of the meat traffic. The Athenians were forbidden to eat the meat of a lamb which had not been shorn once. According to Hippocrates, the Greeks were fond of the meat of dogs which had been castrated while young. Alexander the Great forbade the Lipanese the eating of fish for the reason that the flesh decomposed so rapidly.

In ancient Rome, from the year 388 of the founding of the city, two curule ædiles (cereales) exercised control of the meat market, public shops, and the cooking of meat. Meat condemned by the ædiles was frequently thrown into the Tiber. In one number of *Acta Populi Romani diurna*, in the year 164 A.D., the following notice is found: "The ædile Tetini punished the small butchers because they sold to the people meat which had not been previously inspected by the authorities. The fines were devoted to the establishment of a temple to the goddesses."

The meat of goats was considered by the Romans as unwholesome. On the other hand, the Romans possessed an almost morbid predilection for pork. Fifty different articles of food were made from pork. The sexual organs of female swine were especially sought for by the Romans during the existence of the Empire. Plutarch (*De usu carnis*) says: "Vulva porci nihil dulcius ampla." The dugs (*sumen*) of a sow which had just farrowed were not less esteemed and also the liver of an animal which had been fattened on figs. The longing of the Romans for the genital organs of female swine and the extensive consumption of young pigs brought about such a great decrease in the number of hogs that the Emperor Severus forbade the slaughter of brood sows and sucking pigs,—an edict which was reissued by the Emperor Julianus. Hares were considered unclean and harmful to the digestion, and were, therefore, eaten only by poor people. The meat of rabbits,

on the contrary, was much liked. The young, when cut out of the body or taken away from the teats, constituted a delicacy for the decadent Romans. The meat of oxen was not eaten by the ancient Romans, out of consideration for their mates at work or in the field. They likewise ate no raw meat, for the reason that it had a repulsive, unclean appearance. The opinion prevailed that meat did not become food until it was completely altered by cooking and roasting. Salting meat was practiced by the Romans, and this custom was already common at the time of Homer. Moreover, they already understood the art of preparing sausages; for example, bratwurst (botuli), schnittwurst (incisia), ringelwurst (circelli), and hackwurst (tomacina). Moreover, attention should be called to the fact that, among the ancient Romans, slaughter houses (lanienæ) and meat booths (macelli) existed, which in extent and elaborate organization were not second to other public buildings. With the fall of the Western Roman Empire, these sanitary establishments of Rome were also lost.

Mohammedans.—Mohammed decreed a series of regulations concerning food materials for the communicants of the religious society which was named after him. He forbade in the Koran the use of animals which died a natural death, carrion, blood, pork, the meat of animals at the slaughter of which the name of any other god was called upon, animals which died of asphyxia or of a blow or a fall or by injury from the horns of another animal or which were torn by wild animals ("it is necessary that the animal shall have been killed only by slaughter"), and animals which were killed in honor of other gods.

GERMANY.

(a) From the Middle Ages to the Thirty Years' War.

In Germany the first regulations with regard to meat consumption are met with at the time of the appearance of the apostle Wienfried Bonifacius, at the beginning of the eighth century. Under the direction of Pope Gregory III, he forbade the eating of horse meat on the ground that it caused impure blood and eruptions. Pope Gregory III wrote to the apostle Bonifacius as follows: "I have learned from you that there are certain people among you who eat the meat of wild and tame horses. I therefore warn you that this ought to be permitted to no one, but that it should be prevented by all possible means in the name of Christ, and that atonement shall be made for it, for it is unclean and an abomination."

That not merely sanitary or æsthetic considerations determined the issuance of this bull is apparent from the conclusions reached at the Council of Celeyth in 787, in which the consumption of horse meat was forbidden by the Church for the reason that horse meat was sacrificed and eaten by Germanic peoples in honor of Odin. An attempt was thus made by forbidding the consumption of horse meat to combat a heathen Germanic custom and to promote the progress of Christianity. Moreover, the fear of leprosy was so great that the order in question was most punctiliously observed (Pütz). Later, Bonifacius made known the desire of Pope Zacharius "that bacon and pork should not be eaten in any other form than cooked or smoked." Pope Zacharius forbade the consumption of the meat of diseased animals since it was generally considered as dangerous to health. In the moral courts of justice which the German bishops held in their diocese at the time of Charles the Great, the following among other questions was asked: "Whether any one ate the blood or meat of dead animals or of one which had been torn by another."

From this it is to be seen, as stated by Schmidt ("History of the Germans"), that in those days many customs were still retained which had been ordained in the Old Testament with reference to food materials, although the New Testament had set aside the food laws of the Old Testament.

With the increase in industrial development, the traffic in food materials, on account of its great importance to the health of individuals, claimed the greatest attention for itself. It is apparent that in early times the police power of the fronvogt and burggraf was exercised strenuously with regard to the business of the butcher.

The earliest German records in which the traffic in meat is mentioned are the articles of incorporation of the city of Freiburg in Breisgau, in 1120; the records of Archbishop Arnold I, concerning the city of Medebach, in 1144; and the *Justitia civitatis Augsburgiensis* ordained for the city of Augsburg by Emperor Frederick I, in 1156; the municipal law of Hagenau, 1164; and the records of Duke Henry I, as well as of Boleslaus, in 1224 and 1242, with regard to the cloister of Trebnitz. In the *Justitia civitatis Augsburgiensis* the butchers are mentioned as "carnifices."

In an old record which Bishop Lütold made concerning the butchers' guild in Basel, in 1248, the following regulations are contained: "Thus they shall sell the cleanest and best meat in the highest and best located parts of the market, and in the

common meat booths they shall sell the kind of meat which has previously been sold in such places; while unclean meat—that is, entrails, tripe, etc.—shall be sold outside of the market."

The municipal law of the city of Freiburg in Uechtlande, in 1249, provides heavy punishment for dishonesty in butchers.

The following mention is made of a certain slaughter house in the record of the city of Trachenberg, which was established by Duke Henry III in 1253: "Dotavimus ecclesiae . . . officinas carnium pro sua utilitate et . . . curiam in qua pecora mactantur."

In the year 1261, in a charter which he granted to Mayor von Cerlier, Count Raoul IV of Neuchâtel stipulated that "meat showing eruptions should not be sold for good meat," and also that under the roof of a meat market "pork containing eruptions or meat killed by wolves or dogs, or the meat of any animal otherwise injured, should not be sold."

The regulations concerning butchers in the Augsburg charter in 1276 are very interesting. They prescribe slaughter in a public slaughter house for cattle, sheep and calves, and also compulsory inspection and declaration for diseased animals, thus giving evidence of a hygienic view-point which is not observed at the present time in a number of civilized countries. The charter contains the following statement:

"No butcher shall slaughter a beef animal, or sheep or calf, except in a slaughter house. If, however, animals die in country districts, two citizens and two honest butchers shall be appointed to issue a warning so that the people may suffer no harm from buying bad meat. If a butcher kills a measly hog, he shall sell it to no one without a statement of this fact. All the parts of any such animal shall be sold in the same booth, and if it is sold whole it shall be only under declaration."

Furthermore, it was forbidden to put straw into the abdomen of slaughtered animals or to inflate the meat. In addition to a fine, there was also a severe punishment for a transgression of these laws. Moreover, the guilty person was banished from the city for a month, and "when he comes back into the city, he shall not be allowed to slaughter any meat for the period of a month."

The municipal laws of Nürnberg, 1290, forbade keeping fresh meat for sale longer than two days. Furthermore, it was prescribed that no calf should be slaughtered before it was four weeks old.

Duke Henry III imposed upon the public advocates in Wohlau, in 1293, inspection duties over "duodecim macella carnis et unum factorium."

The city laws of Bamberg in 1306 forbade the sale of measly

meat. In another regulation of the same period, prescribed for Bamberg, "it is also ordered and prescribed for butchers that six men appointed by the city and under oath shall first inspect animals intended for slaughter, and that any meat which these experts consider of doubtful or inferior character shall be so characterized. Any person who shall thereafter sell the same, either in a house or in a market booth, shall be convicted by the testimony of two or more persons under oath, shall be fined five pounds of pennies, or must remain away from the city until he has paid this fine."

In the early records of Duke Boleslaus, in 1307, the following mention is made of a certain slaughter house: "Curia mactatoria quae in vulgari Machehof dicitur."

From the tax-roll of the year 1310 it appears that in Nordhausen there already existed a general slaughter house in which animals were slaughtered and sausages made.

The meat statute of Stettin in 1312 prescribes that "the bone cutters" shall leave the tails on the rumps of slaughtered animals, so that they cannot sell cow meat for steer meat, goat meat for mutton, or the meat of bucks for that of wethers.

The municipal law of Burgdorf, 1316, contains almost exactly the same regulations as those of the charter of Freiburg.

The cities of Brieg and Grottkau received the laws of the city of Breslau from Duke Boleslaus III in 1324. According to these laws, the councilmen were required to choose two men from each line of industrial occupation who were ordered to exercise a supervision over the others, with the right "to use force in preventing the sale of any material which could be harmful to the city."

The statute concerning the slaughter of animals in Kölu and the city ordinances of Berlin in 1343 forbade the sale of "milch cows, animals torn by dogs," as well as "diseased, malodorous and unclean animals."

In Würzburg in 1343 punishment is provided for "all persons who offer for sale measly or mangy meat."

During the progress of litigation between the cloister Frowenrode and the village of Wolfmannshusen in 1346, the following decision, among others, was handed down: "The inhabitants of the village shall, at an appointed time, bring all their hogs to the monastery, where they shall be appraised and inspected by viewing their tongues. Those which from the appearance of the tongues shall be considered clean and worth the estimated price shall be retained by the monastery."

In Dissenhofen, during the fourteenth century, the butchers were allowed to slaughter only so many animals between Easter and Saint Verana's Day as they were able to dispose of on the same day.

The charter of Zwickau in the year 1348 prescribes "that no butcher shall offer for sale in the meat booths measly meat, the meat of sows, immature meat, or any meat which has been cut by Jews. All such meat shall be sold outside of the booths."

Bishop Gerhard of Würzburg ordained the following regulations for the control of butchers in 1372: "They shall not mix bad meat with good and no one shall cut up warm meat or offer it for sale."

According to an abattoir statute of Hamburg in 1375, measly meat was required to be sold in a special booth on a white cloth ("*up deme lakene*"), and the same requirement was enforced in Lübeck and Stade.

In 1376 the butchers in Regensburg were punished because they "*pfinnige Farche, eine Sau mit Tutten und einen trefanten Ochsen zu schlagen willens gewesen.*"

In Aachen, the "planks" (the old meat market which was mentioned in the municipal record of 1385-1386) were under the supervision of the master of the meat and fish market and his assistants. These individuals took account of the organization of the market and were furthermore required to cut off the ears of calves "which had not reached a suitable age," a method of marking them according to an old custom. "Special pig inspectors" were appointed for investigating hogs, and it was their duty to brand unclean hogs with a cut. They were required to take the "oath of pig inspectors," which was as follows: "You shall be pig inspectors, for foreigners as well as for the native inhabitants, and neither for love nor money nor goods nor threats, nor from friendship nor enmity, shall you declare otherwise than as you find the pigs to be."

In the year 1391, in order to carry out more strictly the sanitary police regulations of Augsburg, "a meat market was established, and where the old market stood it was torn down and a market was erected there and was surrounded by a wall."

In Passau, in 1394, a system of inspection of animals and meat was introduced under two responsible councilmen with the assistance of meat inspectors. Moreover, the three butchers of that town were required to take oath annually that they would sell only healthy marketable meat. Measly pork was removed and the

vendor was obliged to return the price of the hog. Likewise, immature meat was condemned and thrown into the Danube.

In Landshut, in 1401, an ordinance was passed prescribing that butchers should sell "Jew meat and measly meat" nowhere except between the meat tables, and that neither measly nor Jew meat should be offered as good meat.

The charter of Wimpfen in 1404 prescribed that measly meat should be sold in a "measly booth," three steps removed from the ordinary meat booths.

In 1414 the butchers in Ulm drew up a resolution which they offered to the council for adoption. In this document the traffic with measly pork, bull meat and Jew meat was regulated. Whoever offered such meat for sale was not allowed to sell any other meat at the same time. If a butcher pickled measly pork immediately after slaughter, and the twelve sworn masters of the market were satisfied of this fact, the butcher was allowed to sell other meat. In the year 1423 it was ordered that hogs which were sold by bakers to the butchers must be put upon the steps of the court of inspection before they were allowed to be killed.

On May 30, 1428, Haintz der Otaker and his comrades took the oath to keep the peace. They had been imprisoned in the tower by the mayor and council at Kempten because they bought a calf in Wytenow which was only eleven days old and killed it in the slaughter house at Kempten and sold it.

Steffen Smawczet von Begerndorf was made to take the oath to keep the peace on May 12, 1434, after having been imprisoned in the city of Regensburg because he attempted to sell hogs in which the bladder worms had been secretly punctured so that the inspectors could not recognize them.

The ordinance of the Council of Strasburg, 1435, forbade the watering of mutton before sale and ordered that sausages must be manufactured in the public meat booths and not in houses.

In the Marbach region in Alsace there were sworn meat inspectors on duty in the year 1437. Their chief duty was to see that the quality of the meat offered for sale corresponded with the price fixed upon it. Only fat meat was admitted to common sale. "In the busy season," butchers were allowed, "for the better accommodation of the people," to exhibit meat of inferior value. This had to be sold, however, in another booth. Furthermore, the meat inspectors were required to determine whether there was anything objectionable in the meat, and whether measly meat had been worked over into sausage.

The Mayor of Munich in 1460 was granted a compensation as meat inspector of two pfennige and three heller.

In Speyer, after the year 1487, "four masters of the meat market" had charge of the organization of the market, inspected the meat and collected fines.

The ordinance of the Council of Nürnberg, 1497, forbade the inflation or swelling of calves' lungs or the lungs of other animals with water or by other means, "for the purpose of making the lungs and their covering appear more marketable, appetizing and larger."

The City Council of Chemnitz, in the year 1506, granted a remarkable concession to the butchers' guild. They were allowed, in the summer time, to slaughter at home, in return for the annual payment of ten guiden, as a result of their "repeated requests and numerous protestations that if animals were killed in the slaughter houses the meat would decompose, become malodorous, and suffer other harm." The butchers, however, were required to promise "not to become a nuisance to anyone" with their slaughtering, not to throw any offal upon the street, but to deposit all offal, "especially of pregnant animals, immediately after slaughter outside of the city in places where no one would be annoyed by it," and to offer no "resistance" when they were again ordered into the slaughterhouses "on account of public exigencies."

All of the regulations thus far mentioned are purely local in character, corresponding to the organization of the feudal conditions of the Middle Ages. When the feudal states became independent, we begin to meet with regulations emanating from central authorities.

Thus, the Mecklenburg state law of 1572 prescribes that the butchers in cities shall be under the control of the stadtvogt with the assistance of two qualified persons. The vogt and his assistants were required to see that no defective or objectionable meat was offered for sale.

In the year 1582 the Palatinate state law prescribed regulations for butchers requiring them to state upon cards the kind of animal which is offered for sale, and to hang the cards in a conspicuous place, "so that the ordinary individual would be able to see and understand it." It was required that the meat of measly hogs, if not badly infested, should be offered for sale outside of the shambles or butcher shop at a place to be determined upon by the authorities.

"In case, however, the measly meat in question is found to be quite unclean, it shall be absolutely rejected and shall not be sold or used. For regulating this matter, two or three honorable men shall be chosen annually in each city, one of whom shall be from the council or court, the second from among the citizens, and the third shall be a butcher or person acquainted with that business. These men shall be meat inspectors and appraisers, and it shall be their special duty carefully and honestly to inspect all meat while alive and also after it has been slaughtered and cut up. They shall also determine according to general market values in each year the high or low value of the meat and set a corresponding price, and they shall have control of the organization of the meat traffic according to the various legal regulations."

Moreover, the butchers were not allowed to kill any calf "which was under four weeks of age or under twenty-four pounds in weight, under penalty of a gulden. No butcher shall be allowed to sell knowingly any unclean animals or other animals which are emaciated or otherwise unmarketable, whether they be cows, wethers, sheep, or other animals, and shall not be allowed to slaughter the same under a penalty of 50 gulden. Moreover, they shall not sell any animal in localities where an infectious plague exists."

With reference to the objective fulfilment of duty on the part of meat inspectors, the public ordinance above cited contains the following: "Regularly appointed meat inspectors shall inspect living animals and shall pay strict attention to determining whether the animal is clean, healthy, and entirely wholesome; and it shall be their duty not to allow friendship or enmity, gifts or presents, or any other condition to interfere with their business."

With regard to the inflation of food animals, in a letter of incorporation of the circuit of Lichtenberg, von Kusel and Novelden, which elector Johannes addressed to the butcher, baker and miller guilds in 1587, we find the following regulations: "Certain butchers and their assistants occasionally use their unhealthy breath to inflate the meat of calves, wethers and bucks, especially in the breast, in order to make it larger and weigh more (?). To stop this repulsive and abominable deception and prevent all harm, all masters of the guilds and accredited meat inspectors shall give diligent attention to these points."

The meat and butcher regulations of the principality of Würtemberg in 1588 prescribed that "the higher and lower order of officials and sheriffs" shall exercise careful control of the slaugh-

tering industry. A general Würtemberg rescript, in the year 1605, forbids the slaughter of "tainted" animals. The butcher ordinance of the same year directs, furthermore, that it shall be the duty of the police "to observe that no other than healthy, nutritious, and clean meat shall come into the market. To this end, slaughter houses, abattoirs and wagons shall constantly be kept clean and no other than healthy meat shall be slaughtered." Every individual who had bought meat from other localities was required to file with the official inspectors an official certificate concerning the health of animals in that region. The inspectors passed upon the certificate, inspected the animals while living, and, after slaughter, determined the marketability of the meat, and "in general attended to all matters pertaining to a faithful service of the public in this regard."

In the "Statut des ehrsamen Fleischhauerhandwerks" of Schwiebus of the year 1590, the following paragraphs are found:

"(8) We shall have care that each master of meat inspection shall slaughter clean, good, vigorous and marketable animals. If, however, one or the other of these officers shall violate this rule, then the other masters shall take counsel and he shall be punished according to the verdict of his associates."

"(24) The Jewish method of slaughter shall be entirely forbidden, and any master of inspection who shall permit a Jew to slaughter according to their custom, whether a large or a small animal, shall forfeit his office."

The communities in "Rappenmünzbesirk der vorderösterreichischen Länder," to which Marbach, Rufach, Basel, Colmar, Münster, Türkheim, Kaysersberg, Amerschweier and Mülhausen belonged, concluded in 1519 at Ensisheim to grant to the farmers an inspection of their animals "at the public market," if the butchers "did not give a reasonable price for their animals and would otherwise retain them at this price."

In Bavaria in 1615 detailed regulations were enacted concerning the practice of meat inspection. In addition to other points, it was declared that no calf under three weeks of age should be slaughtered; that food animals "should be inspected alive as well as after slaughter in the manner required by law, and should be found healthy" by ordained sworn meat inspectors, "who were to be chosen from the most suitable persons by our State and market authorities and ordained, or similarly appointed, one for each village, by the rural courts upon the authority of the Four."

(b) *From the Thirty Years' War to the Present.*

As a result of the Thirty Years' War, the regulations which had been adopted for the control of traffic in food stuffs as well as so many other of the conquests of civilization were lost. In this connection it is instructive to read a letter of Johann Georg, published at Annaburg, February 13, 1654:

"To the Rentkammerverwalter at Naumburgk. Faithful Friend.—Since I have been dutifully informed that in the majority of the cities of our principality there is a lack of slaughter houses and abattoirs, that part of them have been ruined and destroyed by war, but that in the majority of places they have not been rebuilt, therefore, it is said that there is much improper and corrupt practice with regard to food animals, much injustice and self-seeking. It is suspected also that that there is extensive fraud in the estimation of the price of meat. We can not overlook this any longer, since abattoirs and slaughter houses should pay a certain annual tax to the cities, and this has not occurred in the cities of Naumburgk and Zeits up to the present time.

"Therefore, we command you by the authority of this letter to lay this matter before the councils of the cities and to ascertain from them whether they intend to institute and erect slaughter houses and how soon."

In a second rescript of July 15, 1654, it is ordered "to buy or rent at least one slaughter house, since many less prosperous and small cities and localities have made a beginning in the erection of such structures."

There were but few other ordinances which had reference to traffic in meat. An edict of the council at Aachen of April 8, 1664, fixed the price for different kinds of meat, forbade the sale of cow meat as steer meat, and prescribed that "since horned and other food animals (as, unfortunately, is well known) sometimes die, no such diseased or infected animals shall be slaughtered, sold, or held for sale, and all unclean and foul-smelling meat" shall be excluded from the market.

Moreover, the slaughter ordinances in Rostock, 1699, should be mentioned, in which the slaughter and sale of animals which had been bitten by dogs was forbidden. Furthermore, it was forbidden that mangy, dropsical sheep, or those affected with pox, or which had defects in the internal organs, should be brought to slaughter or offered for sale. Likewise the sale of measly hogs was forbidden.

A second general ordinance was passed in Mecklenburg concerning meat inspection in 1710. According to this ordinance, regularly appointed inspectors in cities were required to see that no butchers slaughtered or sold any unsound animals. In case

of doubt concerning the health of an animal, the magistrate or city authorities were required to institute an inspection by the kreisphysicus or some other physician, whose decision was to be awaited. In 1783 the inflation of the fresh meat of calves and wethers by means of the mouth was forbidden, and later also inflation with bellows, in spite of the vigorous protests of certain butchers.

Likewise, a decree of the principality of Hanover in the year 1712 provided severe penalties against the practice of inflating meat in order to give it a shining, voluminous appearance, and finally directs that "all officers or persons who have charge of the veterinary police shall be ordered to have meat markets and slaughter houses visited frequently by their assistants without previous announcement."

Moreover, a Hanover rescript of the year 1716 prescribes that food animals shall be inspected before slaughter, and that when found to be healthy they shall be branded upon the horns and after branding shall be held for three days, after which they may be slaughtered after another inspection. In the same year, the introduction of smoked and salted meat was forbidden "because it is rumored that certain unscrupulous cattle dealers slaughter animals in infected localities and sell the meat after it is smoked or salted."

Likewise, the market ordinance of Leipsic in 1726 forbids the sale of salted or smoked meat, a provision which later was enforced throughout Saxony.

Meat inspection was very carefully regulated by the patent of the principality of Brunswig-Lüneburg, March 31, 1732. This instrument contained the following statement: "No animal shall be slaughtered either for the market or for private consumption before it has been inspected. Two deputies, assisted by two sworn slaughterhouse foremen chosen for this purpose, shall inspect under oath the animals which are designated to them as food animals. If they find them to be healthy and without defects, the animals shall be branded with a G on the right horn and with the same character upon the right loin. After this has taken place, they shall sign a printed certificate containing the result of their inspection. After slaughter the skin must be left attached to the back of the animal until the above mentioned officers have inspected the brands anew and have declared that it is the same animal and that the internal organs have a healthy appearance. For these duties a compensation of six groschen per head in that

city and three groschen in rural districts shall be paid. If, after the slaughter of an animal, it is observed that it is diseased, it must be removed immediately with the skin and the entrails and the whole carcass must be buried four ells deep in the earth."

An imperial Austrian decree of 1753 prescribes that "since so-called cow-herds and skinners have the effrontery to salt and sell to unsuspecting people the meat and tongues of cattle which have died, and since these must be highly dangerous to the human body, all courts are ordered to exercise strict care that such enemies of mankind and self-seekers shall be exemplarily punished."

A mandate of the principality of Saxony of November 6, 1753, directs that "in case of the prevalence of animal plagues, in order to prevent the transmission of these diseases to man, the meat of these diseased animals shall not be sold."

A general decree in Baden on January 31, 1756, forbade the slaughter of calves and goat kids under three and one-half weeks of age.

According to a ducal ordinance in Zweibrück on October 15, 1767, meat inspectors were required to give heed that no calf should be slaughtered which did not weigh at least thirty-two pounds. By a general ordinance, dated April 3, 1756, in Vienna, it was prescribed that all animals of whatever species should be brought for inspection either to the appointed local judges or to the ordained meat inspectors.

According to a Royal Prussian general decree of February 1, 1769, animals which were bloated from excessive feeding with clover or turnips were excluded from inspection during life as well as from compulsory slaughter by a butcher. On the other hand, the patent and instructions of April 13 of the same year prescribed that as soon as a plague appeared in any locality all arbitrary slaughter of cattle without the knowledge of the authorities and the pickling of meat should cease.

On the occasion of an outbreak of rinderpest, an electoral Bavarian ordinance of the year 1796 forbade the consumption of animals which had been killed or which had died of the disease, and added the remark that any person who secretly sold the meat or internal organs of such an animal should be punished as a poisoner.

A general decree in Baden, in the year 1756, was directed against the slaughter of immature calves and kids. In the year 1772, in the same city, an ordinance was passed with reference

to the determination of the adaptability of the meat of diseased animals for food as follows: "That in the case of a diseased animal which died of an epidemic plague, the opinion of a physician with regard to whether the meat can be eaten or not must be obtained. If, however, it died, not of an epidemic, but of some other disease, and the official is disposed to allow the slaughter of the animal, an examination must be made in every case by the meat inspectors or, in their absence, by local officials, and a judgment must be rendered whether the meat is fit to be eaten or not."

This ordinance was passed, as Johann Peter Frank asserts in his "System einer Vollständigen Medizinichen Polizei" (1784-1788), "in order not to increase, except from absolute necessity, the great loss of important food material in such unhappy times."

Highly interesting are the detailed directions for meat inspectors in Bruchsal which were published at the same time and which contained a sample of veterinary science from the eighteenth century. The directions read:

"It shall be the duty of meat inspectors to prevent the public sale or consumption of diseased animals; for example, animals suffering from lung disease (*hartlungenfalige*), jaundice, anthrax, pearl disease, cysticercus disease, cancer, glanders, mange or any other existing disease whereby disgust, disease or plagues may be communicated to and disseminated in man and animals." Moreover, detailed directions were given for the inspection of animals before slaughter (whether the animal intended for slaughter looked lively and fresh in the eyes and whether it would walk readily), as well as after slaughter (inspection of the meat and entrails to determine whether the gall bladder was too large, as was known to be true in the prevailing animal plagues; whether the spleen was too black or too large and whether the intestines were red or blue and tympanitic, etc.).

Furthermore, it was declared "that it should be the chief function of meat inspectors to be on duty from time to time with police assistants, not only in the slaughterhouses, but also in the public market, and that at least one of them should appear daily and give special heed that the meat was always cut up in a proper manner by the butchers, was not sold for more than the quoted price, and that the whole procedure was according to the Articles of the Butchers' Guild and the quotations of the prices of meat."

The first mention which we find of a veterinary surgeon is in the general rescript of Würtemberg in the year 1761, which prescribed in case of an outbreak of an animal plague that "if a trained scientific veterinarian is established in the bezirk, the high bailiff shall have the necessary careful inspection made immediately on the spot by him, or otherwise under the immediate direction of the chief physician by some legitimate practicing veterinarian who has passed an examination."

The electoral government of Bavaria, in a general mandate of August 16, 1761, revived the regulations concerning meat inspection from the year 1615 as follows: "Persons who wish to have animals slaughtered shall give notice of such purpose to duly installed meat inspectors and brand butchers in order that both large and small animals may be slaughtered in the presence of meat inspectors and that thus any punishment may be avoided, and this shall be enforced whether the animal is healthy or infected with a disease, in order that the meat may be buried, or utilized in case it is healthy."

The appointment of "two reliable and trained men for the slaughtering, inspection and description of animals" was prescribed also for those places where there were no butchers.

Of the newer regulations, mention should be made of the Würtemburg ministerial decree of the year 1802 concerning the prevention of the then so frequent cases of sausage poisoning, and another decree from the year 1822, which, in consequence of an outbreak of rinderpest, prohibited all traffic in horned animals and meat, as well as the utilization of the skins, meat, dung and tallow of diseased or affected animals in infected localities. In 1822 the use of the meat of animals affected with anthrax was also forbidden.

A scientific influence manifested itself first in those ordinances which were passed after the Thirty Years' War. This influence, however, aside from the Bruchsal ordinance, was merely of local application, and consequently the action of official decrees was defective.

The previously mentioned J. P. Frank specifically called attention to this unfortunate condition toward the end of the 18th century and simultaneously indicated the importance of the official regulation of the traffic in food materials for the public welfare, in connection with numerous examples. The lack of scientifically trained veterinary surgeons was felt most keenly. This deficiency was obviated by the establishment of veterinary schools at the end

of the 18th century and beginning of the 19th century. As veterinary science flourished and became disseminated, a remarkable change took place with reference to judging the meat of diseased animals. While in earlier times up to the 18th century in all civilized countries the meat of diseased animals, with the qualified exception of measly meat, in which tuberculous meat was also included, was considered as dangerous to human health, veterinary science began to demonstrate that much meat which had so long been held to be dangerous was in reality harmless. Gräber rightfully says: "It is, however, an old experience in the realm of science that new and surprising truths drag everything with them in unreasoning, blind devotion until geniuses sober down again to a cool, reasonable way of thinking." Thus the veterinary teaching of the harmlessness of meat in cases of certain animal diseases very rapidly matured into a general belief that all meat of diseased animals is harmless.

This erroneous view led to a sudden change of opinion on the question of the regulation of meat inspection. While some governmental authorities sought to overcome the increasing protests against official prohibitions by means of constantly renewed ordinances, an unfortunate indifference manifested itself in the other direction. Thus, a ministerial rescript in Prussia in 1826 declared that it was not permissible to compel non-union butchers to slaughter in an abattoir. It was allowed them to slaughter in their own establishments without restriction, as actually happened in the royal palace. As a result, slaughterhouses gradually fell into disuse in certain cities, and in 1842 none of the three previously established slaughterhouses in Berlin were in existence. It was not until the year 1852 that Küchenmeister established the fact that hog cysticerci were the embryonic stages of *Taenia solium* of man, and that the trichina epidemics which, during the 60's of the previous century, appeared in northern Germany to an alarming extent, again attracted public attention to the necessity of regulating meat inspection. When in the year 1864 a commission of the Berlin Medical Society met for consultation concerning preventive measures against the danger from trichina, they considered it their first duty to recommend the establishment of public slaughterhouses for the preservation of the public health.

In southern Germany meat inspection suffered less from the above described retrogression, as is to be seen from the decrees concerning meat inspection for lower Bavaria, October 21, 1836, and for Swabia and Neuburg, January 10, 1857. In the first named

ordinance, a system of instruction for meat inspectors, three grades of meat were distinguished: (1) marketable; (2) non-marketable; (3) non-edible. Other ordinances concerning meat inspection were passed in Würtemberg in 1860, in Bavaria in 1862, and in Baden in 1865, despite the fact that in southern Germany the danger from trichinosis did not exist. In the south German regulations concerning meat inspection, the possibility of the occurrence of trichina in pork was not considered. It is therefore probable that the connection which had been demonstrated by Küchenmeister between the cysticercus of food animals and the tape worms of man furnished the chief impetus to a reorganization of meat inspection in addition to the general feeling of its necessity.

The Kingdom of Prussia in the year 1868 passed a law with regard to the establishment of public slaughterhouses to be used exclusively for this purpose, and laid down the foundation for the practice of a scientific meat control.

The biological investigations concerning muscle cysticerci and trichinæ were the first building stones for the structure of scientific meat inspection. During the 70's, Gerlach carried out investigations concerning the transmissibility of tuberculosis by the consumption of the meat. It was Gerlach also who published the first scientific work on meat inspection ("Die Fleishkost des Menschen"). Simultaneously, Lydtin, the head of the veterinary service in Baden, organized in a model manner a system of practical meat inspection in the Grand Duchy of Baden. The most important advances of our science in the last twenty years are due, however, to Bollinger, who indefatigably and with convincing arguments insisted upon the great public importance of meat inspection, and who, by means of his treatises on meat poisoning, as well as by means of his numerous experimental investigations concerning the virulence of the meat of tuberculous animals, laid a solid foundation for practical meat inspection. These investigations possess a quite peculiar value because they were carried out in an accurate manner with the utilization of the results of bacteriological science which had developed rapidly in the meantime. Schmidt-Mülheim also attacked the problems of our science with effective results in its development. Being a trained physiologist, he treated the science of meat inspection and the methods of slaughtering in a scientific manner in his "Lehrbuch der Fleischkunde." Later he was able to arouse interest in meat inspection by founding a journal which was devoted entirely to meat inspection and the knowledge of animal food materials. Schmidt-

Mülheim, by the trenchant, if not always considerate, articles in his periodical, produced striking results with regard to a more uniform treatment of the meat of tuberculous animals, the practical application of meat inspection to the pure food law which appeared in 1879, and the introduction of "freibanks" in northern Germany.

From this period a large number of veterinarians in the service of public sanitation took the most active interest in the development of scientific meat inspection and in clearing up the numerous problems in this field which still awaited definite solution. The publications of individual abattoir veterinarians and the proceedings of the incorporated societies of these workers furnish evidence that the abattoirs served also the purpose of scientific institutions. Mascher, in his brochure entitled "Wesen und Wirkungen des Schlachthauszwanges," rightfully says: "The requirement of slaughter in abattoirs changes every slaughterhouse into a temple of natural science, in so far as meat inspection is entrusted, not to apprentices in the public sanitary service, but to the masters of veterinary science." Of the strides in advance which have been made in slaughterhouses, I mention merely the construction of an apparatus for the disinfection of condemned animals by de la Croix in Antwerp, the discovery of the most frequent location of beef cysticerci, and the method for sterilizing the meat of tuberculous animals, due to the discovery of Hertwig, formerly the head of municipal meat inspection in Berlin.

The rapid development of meat inspection, however, was made possible only by the fact that the teaching of meat inspection was introduced into the veterinary schools and was incorporated into veterinary curricula, in consequence of governmental regulations concerning the examination of veterinarians; for in this manner trained men are produced who are competent to make a practical application of the theories of meat inspection.

Concerning the history of meat inspection in countries other than Germany, the following notes may suffice: According to Morot, ordinances concerning meat inspection were passed in Scotland in the years 1153 and 1284; in Italy, in 1221 (Naples and Sicily); and in Belgium in 1333 (Tournay). The regulations of the Kingdom of Naples and Sicily were characterized by the draconic punishments which were provided. Butchers were not allowed to slaughter either boar or sow meat as pork, or to deal with animals which died a natural death, or with meat which had been kept over from one day to another, without acquainting the purchasers with these facts. The punishments provided for such cases were the

following: For the first offence, a fine of a lire of gold or corporal punishment; for the second offence, cutting off the hand; and for the third offence, hanging.

In France an edict was issued on January 30, 1350, to the effect that only good, healthy meat should be sold, and also that meat should not be kept after slaughter for more than two days in winter, or more than one and one-half days in summer. According to Morot, meat inspection was practiced in certain communities at an earlier date (1162). The execution of meat inspection regulations was entrusted to magistrates and experts (prudhommes). The first public abattoirs in France may be traced back to the thirteenth century; for example, the *écorcherie* in Amiens. Morot collected numerous ordinances in France which contained interesting prohibitions of the sale of fetuses, still-born animals, and of inflated meat, etc. The sale of measly meat was usually forbidden. Only in case of slight infestation by cysticerci was meat permitted to be sold under declaration of its condition. According to an edict of Robert von Anjou, in which the intolerance of that period is reflected, Jewish slaughterhouses were separated from the Christian. Moreover, it was forbidden to Jews, lepers, and prostitutes to touch with the fingers the meat which was exposed for sale. Another law concerning the inspection of animals and meat was passed on July 22, 1791. Napoleon I established in Paris in 1807 public slaughterhouses at the expense of the city and at the same time closed all private slaughterhouses within the city limits. By a decree dated February 10, 1810, this order was extended to include all the larger and middle-sized cities of France. The establishment of public slaughterhouses in France, however, received a material impetus by the decree of Napoleon III, August 1, 1864, according to which the taxes on the construction capital and the amortizement were to be returned to the city government, while the slaughter fees were not to exceed the expenses of maintaining and managing the institutions.

3.—Present Status of Meat Inspection in Civilized Countries.

In view of the great public value of meat inspection, it is exceedingly strange that not all civilized countries have granted their citizens the benefit of a regulated meat control. A general regulation of meat inspection is found at the present time, outside of Germany, only in Belgium, France, Holland, Spain, Italy, Austria-Hungary, Roumania, and Switzerland. Meat inspection,

however, is practiced in these countries at the present time in very different ways.

COUNTRIES OTHER THAN GERMANY.

With the general organization of meat inspection in Belgium, for the basis of which the meat inspection ordinance of the Grand Duchy of Baden was taken, the more or less imperfect system of other countries stands in marked contrast. Thus, for example, in France there is no law concerning the general practice of meat inspection. It is only in Section 90 of the Regulations for the Practice of Meat Inspection in the law of July 21, 1891, and in Article 63 of "Code Rural" that it is prescribed that abattoirs and private slaughtering establishments shall be subject to the permanent control of specially appointed veterinarians. According to Moulé, however, this regulation is not carried out everywhere in a satisfactory manner. According to my information, governmental meat control in France is, generally speaking, restricted to a certain number of cities. In Holland, the conditions are similar, and the only point which is regulated in a uniform manner is that of the introduction of meat from foreign countries, according to an ordinance of January 1, 1899. The introduction and transportation of the meat of solipeds is forbidden, except whole animal bodies which are provided with skin and respiratory apparatus in their natural connection and which have been declared suitable for food by an official veterinarian. In Spain the meat inspection ordinance of February 24, 1859, is enforced in all provinces; but only twenty-six Spanish cities are provided with public abattoirs. In Italy, a well arranged meat inspection law was passed August 4, 1890; the regulation of meat inspection is, however, left with provincial authorities, whereby a thorough reform is made impossible. In Austria-Hungary, section 12 of the law concerning animal plagues prescribes that the inspection of food animals and meats is to be practiced generally. This inspection, however, is not uniform in Austria-Hungary, since its organization was left with both States and individual crown lands, and was put into practice by these upon very different bases. Perhaps the new Austrian law of January 16, 1897, concerning the traffic with food stuffs, will bring about a uniformity in the practice of meat inspection. There are in Austria at the present time 253 public abattoirs and in Hungary 2,127. Hungary has more public abattoirs than any other civilized country. In Roumania, Article 23 of the General Ordinance concerning veterinary sanitary police, of April 6, 1891, prescribes

that animals intended for general use shall be slaughtered in special slaughterhouses and shall be inspected by official veterinarians. This ordinance has been supplemented by the sanitary law of July 14, 1893, and the regulation of September 11, 1895, concerning the sanitary supervision of the preparation of, and traffic in, food materials and drinks. Finally, in Switzerland, the sanitary investigation of meat intended for public consumption is entrusted to the individual governments of the different cantons. Merely the traffic in imported meat is uniformly regulated by a decree of the Swiss Federal Council of December 1, 1901.

Other countries—as, for instance, England, which is otherwise so well organized with regard to public sanitation and which is called the cradle of hygiene—are entirely without a regulated meat inspection. The only event in this line which has occurred in England is an inspection of the meat offered for sale in private slaughterhouses and on the markets by "inspectors of nuisances," practical men who render their services under the direction of the medical sanitary authorities. A law passed in Scotland in 1892 gives the municipal authorities the right to erect a public slaughterhouse and compel slaughtering to take place in it and accordingly to forbid the further use of private slaughterhouses. Lately the local Scottish authorities and the Scottish Agricultural Department have declared in favor of introducing a general obligatory meat inspection and of appointing veterinarians as inspectors. A beginning has been made in Russia in the establishment of public slaughterhouses in the large cities. In the year 1894 the number of such institutions was 20. Moreover, a regulation on meat inspection was issued in the form of a circular letter of the Minister of the Interior, July 29, 1895, concerning the execution of Article 633 of the Medical Laws. According to this letter, "with reference to the introduction of a uniform inspection of food animals and meats in the whole Empire," the control of emergency slaughter and of traffic in the meat of diseased animals was required to be enforced. In Denmark there are seven public slaughterhouses with meat inspection. Furthermore, in that country the exportation of slaughtered animals is subject to veterinary control by a decree of the Ministry of Agriculture. Plans are being made in Denmark for a general law, according to which universal meat inspection shall be introduced in all cities of more than 2,000 inhabitants, and also a meat inspection in rural districts in cases of emergency slaughter. In Norway and Sweden at the present time meat inspection is practiced in but one

slaughterhouse, in spite of the law concerning communal slaughter houses of June 27, 1892. On the other hand, meat inspection in the cities of these countries has been organized according to the requirements of the law of July 27, 1895; and in Norway this has taken place in all cities of more than 4,000 inhabitants (Norwegian regulation of November 5, 1895, and August 3 and 6, 1897). Every Norwegian city of more than 4,000 inhabitants is compelled to establish a station for the investigation of meat. Strange to say, fees can not be charged for the inspection of meat, even for that which is introduced from foreign countries. For this reason it is very difficult for Norwegian cities to establish slaughterhouses with any prospect of an income. A new Swedish law concerning meat inspection and slaughterhouses of December 22, 1897, is designed to encourage the establishment of public slaughterhouses in Sweden with compulsory slaughter and examination, in order that the required sanitary guaranty may be given for meat intended for export to foreign countries. In the United States only such meat as is intended for export was first subject to inspection and this was on the basis of the meat inspection bill of August 30, 1890. In the year 1895 another law was passed according to which meat intended for internal traffic from cattle, sheep and hogs slaughtered in abattoirs, meat conserve factories, pickling houses and factories for working over meat products must be inspected by official inspectors. The reliability of American inspection, however, is rightfully questioned, since in American hams and bacon sides alleged to have been inspected, numerous trichinæ were demonstrated in the subsequent inspection carried out in Germany. In the year 1896, 23,275,739 animals were inspected before and after slaughter by a total of 579 inspectors in 123 slaughterhouses which are located in 26 cities!* The American meat inspection law is distinguished from all other similar laws by the fact that it (Section 7, c) permits the return of condemned animals to the owner in case of a controversy concerning condemnation. The owner is then merely required to make a monthly report under oath as to what has been done with the condemned animals, and in case they have been sold he is required to state to whom, whether for use as food material, and whether under declaration, and also

* Compare Bureau of Animal Industry, Bul 30, "Trichinosis in Germany." The author weakens his argument for the value of meat inspection by attacking the American system. The German method is poorly systematized as compared with ours, and it is hard for a German to understand how we can inspect animals so rapidly.—TRANSLATOR.

whether all this has transpired after a previous sterilization or not. Finally, Japan has begun to introduce meat inspection in the large cities, since the consumption of the meat of domestic animals has become a more or less prevalent custom among the Japanese.

Meat inspection in Belgium is regulated according to the royal edict of March 23, 1901, in connection with the pure food law of 1890. According to the requirements of this law, all meat in Belgium which is intended for human consumption is subject to official inspection. The only exception is the meat of hogs slaughtered for home consumption. Moreover, according to law, meat inspection is restricted to an investigation of slaughtered animals. It is left to the discretion of local authorities to have an organized and official inspection of animals before slaughter. "The office of inspector can be conferred upon veterinary surgeons only." In communities in which the service may thereby be benefited, another person who has shown the required knowledge may be assigned as an assistant to the veterinary expert (assistant meat inspector). For the veterinary surgeon is reserved the inspection of horses; all animals slaughtered on account of disease, or from necessity; furthermore, all animals which have reacted to tuberculin or are otherwise suspected of being tuberculous, or in the inspection of which by practical meat inspectors, tuberculosis, actinomycosis, foot and mouth disease, measles, anthrax, black leg, pyemia, septicemia, swine erysipelas, sheep pox, sheep scab, paralysis, and other diseases were demonstrated or suspected. Fresh meat, with the exception of mutton, may be introduced from foreign countries only as whole animals, half animals, or quarters, together with the lungs. The introduction of the prepared meat of solipeds from foreign countries is forbidden. Likewise, meat which comes from foreign countries is to be officially inspected and stamped as foreign meat, "Étranger, vreemd."

The Belgian law, in spite of sanitary objections which might be raised to the contrary, allows the introduction of canned meat and sausages from foreign countries. The inspection fees for foreign meat amount to 20 centimes per 100 kg. An appeal from the decision of the meat inspector is permitted within twenty-four hours. If the opinion obtained by the owner of the meat from a veterinarian of his choice is at variance with the previous opinion, the official veterinary inspector must decide the matter.

The Italian regulation of 1890 prescribes: (1) obligatory inspection of all food animals intended for human consumption; (2) establishment of public slaughterhouses in communities of more

than 6,000 inhabitants; (3) entrusting of the direction and management of public slaughterhouses to veterinarians; (4) destruction of dangerous meat; (5) the utilization of non-dangerous meat from diseased animals upon freibanks. (This meat shall be stamped C. B. M. [*carni bassa macellaria*, freibank meat]); (6) the strict regulation of the inspection of meat introduced from foreign countries.

GERMANY.

In Germany the following conditions prevailed up to the present time:* the Kingdoms of Bavaria, Würtemberg, and Saxony, the Grand Duchies of Baden and Hessen, the Duchies Saxe-Coburg-Gotha, and Saxe-Meiningen, the principalities Schwarzburg-Rudolstadt, and Schwarzburg-Sondershausen, as well as crownland Alsace-Lorraine, and the free cities Bremen, Lübeck and Hamburg, have possessed for a longer or shorter time a regular system of meat inspection.

In the Kingdom of Bavaria, police regulations were passed for each kreis on the following dates: for Mittelfranken, February 18, 1885; for Rheinpfalz, April 4, 1884; for Swabia and Neuburg, April 11, 1872; for upper Bavaria, June 2, 1862; for Oberfranken, June 24, 1881; for lower Bavaria, July 21, 1876; for Unterfranken and Aschaffenburg, September 10, 1874; and for Oberpfalz and Regensburg, October 8, 1872. In the Kingdom of Würtemberg uniform inspection of slaughter and traffic in meat was introduced by the ministerial decree of August 21, 1879. The Kingdom of Saxony has had a meat inspection law since July 1, 1898. In the Grand Duchy of Baden a new regulation came into force through the meat inspection law of November 26, 1878; and in the Grand Duchy of Hessen by the meat inspection order of April 10, 1880. In the Duchy of Saxe-Meiningen the decree of March 11, 1865, concerning meat inspection is still in force, while in the Duchy of Saxe-Coburg-Gotha, the general inspection of food animals and meat is regulated by an ordinance of December 22, 1891. In the principality of Schwarzburg-Rudolstadt obligatory meat inspection was introduced by an ordinance of September 3, 1892, and in the principality of Schwarzburg-Sondershausen, by the decree of April 16, 1895. In Alsace-Lorraine meat inspection is regulated by police ordinances of December 13, 1897, and January 1, 1895. Finally,

* The wording of the older ordinances concerning meat inspection may be found in Schlampp Die Fleischbeschau-gesetzgebung in den Sämtlichen Bundesstaaten des Deutchen Reichs; that of the newer in Zeit. f. Fleisch u. Milchhyg.

the free cities Bremen, Lübeck and Hamburg introduced obligatory meat control by decrees of the Senate, February 21, 1889; September 10, 1884; and March 19, 1894.

In the Kingdom of Prussia, the Grand Duchies Mecklenburg-Strelitz, Mecklenburg-Schwerin, and Saxe-Weimar-Eisenach; in the duchies Anhalt, Brunswick, Oldenburg, as well as in the principalities Lippe and Reuss, general ordinances concerning obligatory inspection of all food animals were still wanting. Trichina inspection existed as an obligatory or facultative measure. Furthermore, there were restrictions on the traffic in meat of diseased animals and a veterinary inspection of horses intended for slaughter was required. A control of cases of emergency slaughter was also practiced to some extent, and, on the basis of special slaughterhouse laws, a model meat inspection existed in a large number of cities.

In the course of the last ten years, public slaughterhouses in Northern Germany have rapidly sprung up. For example, the number in the Kingdom of Prussia has increased during the last decade by 200. Meat inspection in the rural districts of Northern Germany was, however, still undeveloped. Furthermore, the inspection of imported meat was defective and lacked uniformity throughout the whole German Empire, in so far as it was mainly restricted to the inspection of pork for trichina. The provisions of the imperial law of May 14, 1879, concerning the traffic in food materials, condiments and manufactured articles gave authority everywhere for supervision of the traffic in meat. These provisions, however, had no lasting effect, since it was not stated how the law should be enforced regarding the compulsory inspection. The Imperial law was designed merely to prevent, under threat of punishment, the traffic in defective meat. This kind of protection, however, is insufficient, since violations of the law are demonstrated only in isolated cases or accidentally and often after the bad results from the sale and consumption of injurious meat have been produced.

For these reasons the passage of an imperial law concerning the obligatory inspection of all food animals before and after slaughter was demanded as a necessity. The significance which was ascribed to the passage of such a law appears in the words of Thronrede, in which the law was announced: "In order to avoid the dangers which are connected with traffic in uninspected meat intended for human consumption, whether of domestic or foreign origin, the general introduction of the inspection of food animals and meat has been considered by the allied Regierungen. I hope

that during this session you will prepare a bill regulating this matter."

Now the German Empire possesses, in the law of June 3, 1900, concerning the inspection of food animals and meat, the foundation of a general uniform execution of meat inspection in all of the allied States. The passage of this law constitutes a mile post for public sanitation and veterinary science in Germany. After this law became effective, Germany became the first civilized country in which animal food was subjected to a regular official control, and veterinary science may point with pride to the fact that this significant hygienic result is partly due to the indefatigable efforts which the representatives of veterinary science have put forth for several decades toward introducing a general compulsory inspection of food animals and meat.

4.—Practical Execution of Obligatory Meat Inspection.

The practical execution of obligatory meat inspection will assume a different form in large cities and in rural districts.

Meat Inspection in Cities.—In cities, as well as in other communities with a considerable number of inhabitants, the erection of public slaughterhouses and the necessity that all animals intended for human food should be officially inspected and slaughtered in such institutions, constitute the foundation of a proper system for regulating meat inspection. Stiles rightly says: "A well regulated system of slaughterhouses is as necessary to public health as is a well regulated system of schools to public education."* Without public slaughterhouses, obligatory meat inspection in large cities remains a half-way measure, for the reason that it is impossible, without an extensive system of officials, to supervise the traffic and slaughterhouses of individual butchers scattered here and there. The minimum number of inhabitants which requires the establishment of public slaughterhouses is in part determined by local conditions. It is desirable, however, that as many communities as possible be provided with general slaughterhouses. In the Prussian Regierungsbezirk of Oppeln, the construction of public slaughterhouses, stimulated by the Imperial Government, has progressed to such an extent that all cities of more than 5,000 inhabitants are provided with one. In

* "The Country Slaughterhouse as a Factor in the Spread of Disease." (Yearbook of the U. S. Department of Agriculture for 1896, pp. 155-166.)

Würtemburg and Baden even the majority of small cities with 3,000 or less inhabitants are provided with them. Similar conditions are observed in Alsace-Lorraine. In this region 18 of the 69 public slaughterhouses are located in communities with less than 2,000 inhabitants.

Public Slaughterhouses in the German Empire.—The number of public slaughterhouses in the German Empire is at the present time (1901) about 740, distributed as follows: Prussia, 381; Bavaria, 77; Würtemberg, 62; Saxony, 33; Baden, 48; Hessen, 14; Mecklenburg-Schwerin, 10; Mecklenburg-Strelitz, 2; Saxe-Weimar, 3; Brunswick, 1; Saxe-Meiningen, 4; Saxe-Coburg-Gotha, 3; Anhalt, 4; Schwarzburg-Sondershausen, 1; Schwarzburg-Rudolstadt, 1; Lippe-Detmold, 1; Alsace-Lorraine, 69; the Free Cities, 3.

There are no slaughterhouses in Oldenburg or Saxe-Altenburg. According to Schwarz, there are about 675 communities in the German Empire with more than 3,000 inhabitants and about 400 with more than 500 inhabitants which are still without a public slaughterhouse.

Public Slaughterhouses in Prussia.—In the Kingdom of Prussia there are at present 381 public slaughterhouses which are distributed in the different provinces as follows:*

East Prussia, 42; West Prussia, 33; Pomerania, 21; Brandenburg, 28; Posen, 44; Silicia,† 55; Saxony, 21; Schleswig-Holstein, 2; Hanover, 21; Westphalia, 44; Hessen-Nassau, 17; Rhine-province, 51; Hohenzollern, 2.

Meat Inspection in the Rural Districts.—In rural districts and in very small communities, the erection of public slaughterhouses is out of proportion to their utilization. Moreover, in smaller communities the conditions are so simple that slaughtering might be supervised without such institutions. We may, therefore, do without public slaughterhouses in rural districts. On the other hand, according to the example of the Regierenbezirk of Oppeln, the erection of communal or partnership slaughterhouses for neighboring small communities is to be recommended.

* In the year 1890 the number of public slaughterhouses in the Kingdom of Prussia was 180.

† Up to the year 1886 there were but six public slaughterhouses in Oppeln.

Furthermore, as Lohoff has stated, it is at least desirable in rural districts that quarters be established for a meat inspector, an inspection station for imported meat, and a local freibank.

The following may serve as a guide for the construction, equipment and management of public slaughterhouses in large communities, and slaughtering establishments in rural districts, the enforcement of compulsory inspection, and the accessory institutions which are inseparable from meat inspection (freibanks and the insurance of food animals).

(a) Public Slaughterhouses in the Larger Communities.

Structure and Equipment.—It should be distinctly remembered that the interests of the movement will be best served if the construction of public slaughterhouses is not entrusted to butcher unions, as frequently happens, but is kept within the control of the community itself. The fear of an insufficient income, which is entertained by certain communities, is quite unfounded, as is shown by the yearly reports on the management of corporation slaughterhouses. Communities have full power, by fixing the fees at the proper rate, to make the income and expenses balance each other. At any rate, when in exceptional cases a slaughterhouse is managed by a corporation under directions given by the local government, all coöperation in the choice of technical officials for meat control must be prohibited to the corporation. It requires no argument to show that institutions designed for the public welfare serve their purpose only when directed by officials who labor in an objective manner and not when directed by interested industrial guilds.

It is often asserted by the opponents of public slaughterhouses and of compulsory slaughtering in these places that the price of meat is increased by these institutions. This assertion is disproved by experience, as was first clearly demonstrated by H. Falk and recently by Kjerrulf, by means of the most painstaking statistical compilations. The fees for slaughter and inspection, which are devoted to the payment of the expenses of the management of the slaughterhouses, do not cause an increase in the price of meat, since, by the utilization of public slaughterhouses, butchers save expenses in other directions. The butchers are no longer compelled to manage their own slaughterhouses; they save the fuel required for heating the scalding water; they realize the possibility of an economical utilization of cold storage and many other advantages. It appears, therefore, in this as in all other

industrial lines, that business can be conducted on a large scale cheaper than on a small one.

Concerning the expenses and income of municipal public slaughterhouses, the opinion of the Imperial Saxon Commission for Veterinary Service of April 23, 1893, contains the statement that the establishment of a municipal public slaughterhouse in no sense financially embarasses the city and does not burden the citizens with new taxes, but that the capital devoted to the construction and management of a slaughterhouse is a good investment under all circumstances. The building fund may be obtained for 3½ per cent. interest, but by the surplus of the business may be made to yield 5 to 6 per cent., and in the course of from 35 to 40 years the debt is extinguished. The community thus, in a certain sense without expense, becomes the owner of a valuable property free from all encumbrance.

In the construction of slaughterhouses which must be used exclusively, consideration must be had for all requirements with regard to the supervision of the industry, the convenient occupation of the laborers, and the preservation of the meat. The chief requirements are sufficient stalls for the animals, roomy halls for slaughtering (German system), special arrangements for cooling the meat, and well-kept cold-storage plants for the preservation of the refrigerated meat.*

The French room system, in comparison with the German hall system, has several disadvantages, especially in regard to the possibility of supervising slaughtering and the cleaning of the slaughter pens. The material for the construction of floors, ceilings, and walls is to be selected with a view to keeping the whole institution clean, and, in case of an emergency, to making possible a thorough disinfection. For convenience in cleaning the stalls and slaughtering stands, every abattoir must be provided with flowing water. For the isolation and slaughter of infectious animals a separate slaughter hall with stalls (plague house, together with sanitary police slaughterhouses) is to be constructed; and for carrying out careful investigations—aside from the service rooms of the meat inspectors—a post-mortem room and laboratory room for simple microscopical, bacteriological and chemical investigations, together with accessories (stall for experimental animals), are required. Furthermore, attention should be given to the construction of a special house for horses and a freibank with sterilizing

* Compare Schwarz, "Bau, Einrichtung und Betrieb von öffentlichen Schlachthöfen." Second edition. Berlin: 1900.

apparatus. For the artificial illumination of abattoirs with a view to the careful practice of meat inspection in the evening, only the electric light and the so-called millenium light (combustion of illuminating gas under high pressure and with strongly woven or double mantels) are suitable. Finally, attention should be given to another matter, which, unfortunately, heretofore has not been sufficiently considered, namely, apparatus in abattoirs which makes possible the disinfection or technical utilization of organs and whole animals which have been absolutely excluded from use as food. In small abattoirs in which the number of condemned parts and animals is inconsiderable, the burning of such parts is satisfactory. In other abattoirs, however, in which this procedure does not pay, arrangements should be made by means of which this refuse matter may be utilized to the best advantage. Attention should be called in this connection to the fact that, according to recent methods, it is possible to save as much as 20 per cent. of the original value of animals by a suitable utilization of the carcass, and that we are thus in a position to preserve a very considerable part of the national wealth for productive agriculture and thus to reduce the loss which agriculture would sustain through the condemnation of individual organs and whole animals in consequence of meat inspection. Furthermore, the customary procedure, which has been quite general up to the present time, of turning over to knackers the animals and individual parts which have been excluded from use as human food, can not be considered as a satisfactory solution of this problem. For experience has shown that the journey from the slaughterhouse to the knacker's establishment and the disposition of the meat in such places offers abundant opportunity for underhand traffic with dangerous meat. Therefore, it is desirable that knackers' privileges, which are still to some extent in force in the eastern provinces of Prussia, should be withdrawn by the municipal authorities in accordance with the powers which they possess (law of May 31, 1858, and of December 17, 1872). The knacker's legal right of coercion is touched upon in the imperial Prussian edict of April 29, 1872. According to this document, everyone in the judicial district is required to deliver to the knacker animals dead of infectious diseases, meat which has stood too long, and also animals which were found "unclean"* at slaughter (sheep excepted). That this edict is still in force is apparent from a decree of the Prussian Oberverwaltungsgericht

* For the significance of the term "unclean," see page

of October 8, 1891, which stated this point explicitly and which declared a police regulation illegal in which a butcher was forbidden to deliver a trichinous hog to the knacker who was permitted the coercion right upon animals in his district which were found upon slaughter to be unclean. It was also asserted that the claim of the knacker to the delivery of unclean animals was not merely of the nature of a private right; for, in creating knackers' establishments and granting them privileges with right of coercion, one of the objects aimed at was, by means of getting rid of dead and diseased animals, under regulations established by the municipal authorities, to reduce the danger to health and to protect the inhabitants against epidemics.

The legal right of coercion on the part of knackers must now be characterized as a hygienic anachronism; for knackers' establishments have in many instances failed to serve the purpose for which they were created. From the many examples, mention may be made only of the cases of criminal prosecution which have been brought within the past few years on account of the sale of knackers' meat by the knackers, their apprentices, butchers, and food dealers in Berlin, Hamburg, Hagen, Magdeburg, Barmen, Stassfurt, Glonn, Uffenheim, Meiderich, Grossgerau, Vilbel, Düsseldorf, Dalheim and Breslau. In the case of the last named city, it was shown in the testimony that the knacker had for years carried on an extensive business with the meat of measly and trichinous hogs, and that these facts had first been brought to the attention of the community when, in consequence of the consumption of the knacker's meat, three persons had been affected with trichinosis and two had died.

In establishing public abattoirs, attention should also be directed to devices for the rapid and odorless destruction of the dung and the contents of the stomach and intestinal tract of slaughtered animals and to the establishment of a direct connection with a railroad; to the construction of a special platform upon which animals imported from foreign countries are unloaded without coming in contact with native animals, and, finally, to the establishment of separate stalls for food animals imported from foreign countries.*

Accessory Industries in Connection with Abattoirs.—Among the lines of industry (pickling cellars, smoking rooms, meat

* With reference to the establishment of an abattoir to meet the requirements of modern times, consult the description of the new slaughterhouse and stockyard in Barmen by Koch, "Zeit. f. Fleisch- u. Milchhyg.," Vol. 4, No. 6.

mincing establishments, sausage factories, stripperies, skin salting rooms, albumen and blood fertilizer factories, tallow factories, oleomargarine factories, and inoculation establishments for securing vaccine) which are found occupying a part of abattoirs, only such are to be considered permissible as may be conducted without odor and without interfering with the real business of the abattoir. The skin salting industry, and especially the manufacture of oleomargarine, are not suitable for inclusion in abattoirs, for the reason that they can not be conducted without an odor. On the other hand, institutions for obtaining animal sera may be very properly connected with abattoirs. In order that in the construction of public abattoirs all the requirements demanded by the interests of the various industries and by the sanitary police regulations may be literally fulfilled, it is desirable to follow the example of several cities which have appointed the future director at the very beginning of the work of construction of the abattoir in order that he might be present to assist the architect in planning the institution. Abattoirs are sanitary institutions in which veterinarians perform their duties. The latter should, therefore, be called upon to coöperate in projecting the plan of the abattoir in so far as they may furnish suggestions for necessary details of structure and the most convenient equipment of the abattoirs. If this point were always observed, the number of public abattoirs with conspicuous defects in structure or arrangements would be much smaller.

Connection of Slaughterhouses with Stockyards.—The connection of slaughterhouses with stockyards gives rise to the danger that plagues, especially foot-and-mouth disease, may be transmitted from slaughterhouses to the stockyards. As a means of preventing this, the Prussian Technical Deputation for the Veterinary Service (decree of the Minister for Agriculture, Public Domains and Forests for February 19, 1894, to all of the Regierung Presidents) recommended the following measures: If the transmission of plagues from slaughterhouses to stockyards is to be prevented with certainty, both establishments must be separated from each other in such a manner that no animals, feeding stuffs, dung, or other materials which are suspected of being contaminated with the contagium are transported from the slaughterhouse to the stockyard. Butchers and other persons who come in contact with animals in the slaughterhouses shall be allowed access to the animals in the stockyards only after their clothing and footwear have been subjected to a satisfactory cleaning process. It is

necessary to have an arrangement which does not permit animals which have been brought to the slaughterhouse to be driven away from it again without police permission. This permission is to be granted only in case the animals are to be transported by rail to another slaughterhouse under regulated veterinary police supervision.

If there is connection between the stockyard and the slaughterhouse, the latter must be connected with the railroad so that animals may be brought to the slaughterhouse directly or without contact with the stockyards.

The introduction of animals with or suspected of having an infectious disease (pneumonia, mange, foot-and-mouth disease) requires the erection of special platforms for unloading the animals and a large space (plague stall) for temporarily holding them.

Moreover, suitable spaces (stalls and recesses) of sufficient number and size should be provided in connection with the slaughterhouse for the temporary reception of the animals.

It is also a requirement of veterinary sanitation that the stalls and recesses be built in such a manner as to make possible the rapid escape of urine, and that the floor in them, including the passage ways beneath them, should be made of cement.

A careful veterinary investigation of all animals brought to the stockyards is necessary at the time of their arrival and when they are taken away. For this purpose, long and broad platforms should be constructed, upon which inspection of the animals may take place immediately after or immediately before they are loaded on the cars. For receiving and shipping small animals (sheep and hogs) it is desirable to have constructed two adjacent platforms with impervious floors, one of which may serve for loading and unloading the animals which are transported in the upper deck of the cars. Whenever it is necessary to drive or transport animals from the stockyards to the slaughterhouse, the utilization of a special passage way for this transportation is to be recommended, so as not to cross the passages of the stockyards through which export animals have passed.

The stockyards should contain sufficient space for the construction of large halls, recesses and stalls. The spaces which serve for the reception of hogs must be arranged so as to be reached directly by special unloading platforms, so that the passages used for driving hogs in and out shall not be traversed by cattle and sheep.

It is desirable also that the unloading or loading of sheep shall

be conducted separately from that of cattle in the stockyards. A large observation stall should be constructed in a suitable part of the stockyard and as near as possible to the slaughterhouse, and diseased or suspected animals which ought not to be brought directly into the slaughterhouse are to be received in this stall. The manure must be removed daily from the various enclosures in the stockyards in which the animals stand and must be taken to the dung heap. The latter must be located outside of passages and places over which animals are driven.

(b) Slaughterhouses in Rural Districts.

In rural districts attention ought to be given to securing perfect cleanliness and satisfactory ventilation of the individual slaughtering places and of the spaces designed for the reception of slaughtered meat. The possibility of a technical inspection of the meat should also be provided for. The sterilization of confiscated meat should receive more serious attention in the future in rural districts, and it is especially desirable to check the practice of simply throwing condemned organs upon the dung heaps. On this point stringent orders are issued in connection with the imperial meat inspection law. For the preliminary reception and denaturalizing of the confiscated meat, Lohoff recommends that hogsheads filled with creolin water should be placed in the yards of private slaughterhouses.

In the Kingdom of Prussia the following requirements are made in issuing permits for private slaughterhouses:

The height of the butchering rooms shall be at least three meters and they must be of sufficient size to permit of windows on two opposite walls for light and ventilation. Or, if light and air enter the room from only one side, care must be taken to secure the construction of one or more air-shafts for ventilating purposes, if the free space of the room is not supplied with a sufficiently rapid change of air. The walls of the butchering room are to be covered with cement and are to be coated to the height of at least two meters with a light, not red, oil paint. The floor must be impervious to water and must not be planked. For the fluid refuse and bloody water, which can not be allowed to run into the general city sewer system, a water-tight cesspool must be provided, with a tight cover, as near as possible to the butchering room and connected with it by a drain. Into this cesspool all wash water must be allowed to flow by gravity. In inhabited regions in

summer the cesspool is to be cleaned and disinfected after each slaughter; in the winter, twice a week. The solid slaughterhouse refuse is either to be removed immediately after slaughtering or collected in a special water-tight receptacle and covered with caustic lime until it is removed.

The slaughterhouse must be so constructed that a view from the street is impossible. As a rule, slaughtering in the yard is to be prohibited.

If a supply of pure water is not provided for in other ways, it should be acquired by the slaughterhouse being so placed that a spring is found in the yard, or water should be piped into the house.

(c) Compulsory Inspection.

For the satisfactory regulation of meat inspection, the fundamental principle should be established that all animals intended as food for man are to be inspected before and after slaughter. The exceptions which are made in older regulations in meat inspection with regard to small animals (sheep and hogs) and young animals are without hygienic foundation and are to be discontinued. For diseases frequently occur in small animals so as to render the meat dangerous or of inferior value as food. It is only necessary to call attention to tuberculosis and cysticerci in hogs, to erysipelas in these animals, to hog cholera and swine plague, as well as to the numerous organic diseases which occur not only in hogs but also in sheep and goats. With regard to young animals, it should be remembered that those pyemic and septic diseases, which have unfortunately become so well known through cases of meat poisoning, are not rare. Moreover, exceptions in favor of animals slaughtered for private use should not be made, for the person who slaughters them may not only injure himself by enjoying this exception, but also his family and servants. It should also be remembered that meat ostensibly slaughtered or alleged to be slaughtered for home consumption frequently comes into other hands, even if usually limited only to relatives. Thus in Berlin in the last twenty years sporadic outbreaks of trichinosis have frequently occurred after eating pork which had been slaughtered for private use outside of Berlin, and which, according to precepts of the regulations in the place of slaughter, was not required to be subjected to an examination on account of its being intended for private purposes.

(d) Freibanks.

The introduction of so-called freibanks or similar institutions such as have long existed in southern Germany are inseparable from the regulation of meat inspection. Although public sanitation is primarily concerned in withholding dangerous meat from traffic, it has, nevertheless, the function of determining that the traffic in meat shall be conducted in a proper manner. No more of the capital represented by food animals should be withdrawn from the national resources by confiscation than is absolutely necessary for the protection of human health. This tolerance is, moreover, indicated from a consideration of the production of the cheapest possible animal food for the greatest number of people. Far more human beings die from defective nutrition than from the harmful properties of meat. Moreover, the national resources suffer the loss of millions (Bollinger) when only one-half to three-fourths of one per cent. of the food animals which represent values of five to six milliards is excluded from consumption.*

Some animals must therefore be admitted for human food although not in perfect health, but the meat of which must be

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* From April 1, 1892, to March 31, 1893, in 243 public slaughterhouses of the Kingdom of Prussia, 22,487 horses, 600,501 cattle, 914,216 calves, 916,962 sheep, 4,726 goats, 8,678 other not separately counted calves, sheep and goats, and 1,873,266 hogs were slaughtered, as well as an additional number of 30,056 horses in horse slaughterhouses. Of this total number, the following numbers were found unfit for human food: 152 horses = 0.3 per cent.; 4,067 cattle = 0.68 per cent.; 1,171 calves = 0.13 per cent.; 603 sheep = 0.066 per cent.; 32 goats = 0.64 per cent.; 6,297 hogs = 0.34 per cent.; and parts of animals in the following numbers: 581 horses = 1.1 per cent.; 65,891 cattle = 10.98 per cent.; 2,412 calves = 0.26 per cent.; 39,682 sheep = 4.3 per cent.; 79 goats = 1.6 per cent.; and 59,267 hogs = 3.1 per cent. In the year 1896, in 321 Prussian slaughterhouses, 28,162 horses, 726,824 cattle, 1,088,784 calves under six weeks of age, 1,096,997 sheep and goats, as well as 3,018,367 hogs, were slaughtered. From this total the following numbers were withheld from the market as entirely unfit for food: 208 horses = 0 74 per cent.; 3,716 cattle = 0.51 per cent.; 1,892 calves = 0.17 per cent.; 522 sheep and goats = 0.04 per cent.; 3,654 hogs = 0.12 per cent.; and parts of animals in the following numbers: 126 horses = 0.44 per cent.; 4,318 cattle = 0.59 per cent.; 414 calves = 0.079 per cent.; 2,267 sheep and goats = 0.2 per cent.; and 4,984 hogs = 0.16 per cent.

In the Kingdom of Saxony the following animals were slaughtered:

	Number	Admitted to market without restriction Per cent.	Destroyed Per cent.	Delivered to the freibank Per cent.
1894	785,915	.... 99.18	.... 0.15	.... 0.66
1896	876,000	.... 99.4	.... 0.13	.... 0.71
1899	1,001,388	.... 99.13	.... 0.11	.... 0.76

regarded as harmless according to sanitary and experimental data. The number of these diseased animals admitted for food in the raw or cooked condition is very large (tuberculosis, swine erysipelas, swine plague, hog cholera, actinomycosis, measles and other parasitic diseases, icterus, bloody or watery meat, or meat of an abnormal odor). The meat of such animals should not be admitted to sale without restriction, since the consumer has the right to demand that in the open market only the meat of healthy animals or those which are affected with unimportant diseases—that is, products which are marketable or fit for food—shall be found. On the other hand, there is not the slightest objection to the sale of unmarketable meat or that which is conditionally fit for food in a special booth and with a declaration of its defects so that the purchaser may be fully apprised of the character of the meat he is about to purchase. The pure food law gives a legal basis for the institution of a proper traffic with non-marketable meat, for it allows the sale of "spoiled"—that is, non-marketable—meat under the necessity of a declaration.*

The institution of a freibank, however, not only renders it certain that the consumer will obtain in the open market what he thinks he is buying, but it also makes it possible for the sanitary police to give permission under certain regulations and restrictions to traffic in meat;—for example, measly meat after previous cooking, pickling, or preservation in cold storage;—which in the absence of a freibank would be withheld from the market as dangerous to health—for example, the meat of measly animals—and destroyed.

If it is said that the classification of meat as marketable and not marketable may offer difficulties, this must be admitted for individual cases on the border line; but, even in these instances, a decision is much easier and simpler than when in the absence of a freibank we have to determine whether the meat is marketable or whether it should be destroyed. For in the latter case we have a sharp line of demarcation, while with the institution of a freibank, on the other hand, there is a broad boundary line between marketable meat and that which ought to be destroyed.

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* The terms "marketable" and "non-marketable" are old trade expressions which are associated with the legal measures of the old regulations of meat inspection and trade orders that only marketable meat should be sold in the ordinary meat booths, while non-marketable meat should not be sold there. "Suitable for market," "not suitable for market," "shop not clean," and "shop clean" are also synonymous terms.

From the standpoint of the tradesmen who see in the freibank an undesirable competition, many objections have been raised against the institution. One such objection is that meat inspectors are not in a position in all cases to give a proper decision concerning the marketable or non-marketable character of the meat. The answer to this objection is that which was given by Bollinger to an opponent of the freibank. "Our abattoir veterinarians have to answer almost daily the questions which you have put to me. Experiments in the laboratory as well as experience in in practice have taught that abattoir veterinarians are very competent to determine what meat shall be considered 'wholesome,' 'inferior,' or 'dangerous to health.'" In consequence of the new regulation concerning the requirement of a guaranty in traffic with food animals which was brought about by public statutes for the German Empire and by imperial decree, it is pleasing to note, as appears from the proceedings of the Twenty-second Session of German Butchers, that an interest in the proper utilization of harmless but inferior meat has been awakened among the butchers.

It has been a universal experience that meat exposed upon the freibanks always finds a ready sale on account of the smaller price which is associated with the declaration. No injustice is done any one by the introduction of the freibank, for every person is free to buy meat upon the freibank or not. "Volenti non fit injuria."

In instituting a freibank, it is assumed that an underhanded traffic with non-marketable meat will be prevented. In ordinances with reference to this point, provision is to be made to permit the sale of meat only in small quantities and exclusively to persons who are to eat it themselves and to exclude from patronizing the freibank all butchers, sausage makers, hotel and restaurant keepers, as well as other middlemen. An effective control of the traffic with freibank meat is possible, however, only in communities of not too great an extent. In large cities in which this control is not possible, an institution similar to the freibank is to be provided in the place of the freibank, as, for example, in Berlin Here an attempt is made to eliminate the middleman and the dangers connected with his business under certain circumstances, by not permitting unmarketable meat to be offered for sale except after cooking.

The objections which were once raised by landowners, to the effect that agriculture might be injured by the institution of freibanks, are quite unfounded. On the contrary, it is on agri-

culture that the freibanks have conferred the most benefit, for they permit the legitimate utilization of the meat of animals which are not in perfect health, which meat was formerly either entirely destroyed or sold for merely nominal prices to a questionable class of butchers. As a pleasing evidence that this conviction has taken root among the landowners, we must regard a decision arrived at several years ago by the German Agricultural Council to send representatives to the Reichsregierung and Landesregierungen in the interest of a general introduction of freibanks, since they were necessarily correlated with the practice of obligatory meat inspection.

History of the Freibank.—The freibank and compulsory declaration for defective meat are old German institutions, the necessity for which became evident during the empirical regulation of meat inspection. Thus, the Augsburg charter (1276) prescribed that "any butcher who shall slaughter a measly animal shall sell it to no one without his knowing its condition." Such meat, in so far as its sale was permitted at all, could not be sold in the ordinary meat booths, but the sale must take place in a booth which was separate and some distance from the ordinary meat booths. The freibanks were sometimes called "measly-banks," for the reason that they served chiefly for traffic in measly meat. With regard to such "measly-banks," the charter of Wimpfen (1404) provided that they must be located three steps from the ordinary meat booths.

The belief that in early times freibanks existed only in Southern Germany is not correct; for, according to a butcher law in Hamburg in 1375, it was required that measly meat should be sold in a special booth and upon a white cloth. Similar requirements were also in force in Lübeck and Stade. (Compare p. 16.)

The institution of freibanks has become established also in Italy, Belgium and France, and this constitutes a further proof of their necessity.

Present Distribution of Freibanks in Germany.—The institution of freibanks has for a long time existed in connection with all the abattoirs in Bavaria, Würtemburg, Baden, Hessen, and Alsace-Lorraine. At present, moreover, the majority of abattoirs in northern Germany also possess freibanks. The introduction of freibanks was provided according to law simultaneously with obligatory meat inspection in the Duchy of Gotha (ministerial regulation of December 22, 1891). Furthermore, the imperial

Prussian General President of Silesia and Posen conferred upon the presidents of the Regierungen the power to make every possible effort toward the introduction of freibanks. Accordingly, the president of the Regierung at Bromberg provided, by means of the police regulation of June 15, 1893, for the introduction of freibanks throughout his entire Regierung. In the year 1899, 345 of the 381 public abattoirs in the Kingdom of Prussia were furnished with freibanks.

The great economic value of freibanks is shown by the following data:

In the Kingdom of Saxony in 1892, 0.25 per cent. of the food animals which were inspected in the public slaughterhouses were entirely withdrawn from the market, while 0.42 per cent. were admitted for sale upon the freibank. In the year 1894 the percentage of the total condemnations and consignments to freibank were 0.15 and 0.66 per cent.; in the year 1899, 0.11 and 0.76 per cent. In the absence of freibanks, all of the food animals which were sold upon the freibank must have been entirely excluded from market; and these conditions prevail wherever freibanks have not been introduced.

In Leipsic, in 1891, the meat of 604 cattle, 89 calves, 28 sheep, 983 hogs, and 104 parts of animals, with a total weight of 271,609 kg., were utilized upon the freibank. The average proceeds from non-marketable animals, after deducting the expenses, were as follows: For cattle, 326 99 marks; for calves, 23.81; for sheep, 22.3; for hogs, 90.63; viz., 58.3 pfennig per pound of beef, 44.2 per pound of veal, 54 5 per pound of mutton, and 57.4 per pound of pork. (The price of marketable meat was, for beef, 75.6 pfennig; for veal, 55.5; for mutton, 58 8; for pork, 61.) This same average of proceeds was attained in Leipsic in later years also. From these data it appears that the sale of meat on the freibank makes possible a quite extensive utilization of the meat of diseased animals.

The determination of the price of freibank meat is left with the owner or seller of the meat, according to the industrial regulation.

5.—Technical Supervision of the Meat Traffic.

(a) Scientific Experts.

Training.—It is now generally recognized that it is a part of the chief functions of veterinary medicine, through the supervision of meat inspection, to protect human health against danger from

eating meat. In this regard a very significant movement has taken place, since at present the special line of veterinary science—that is, meat inspection—which was previously held in less esteem, is no longer without proper consideration. The most satisfactory recognition of the improvement of meat inspection was given by the deliberations of the German Reichstag concerning the estimates of entrance qualifications for students of veterinary science. It was thereby made plain that for the practice of meat inspection in the German Empire the proper qualifications for the study of veterinary science must be required. This movement is based upon the recognized fact that meat inspection is not a subordinate branch of science, but that comprehensive attainments and a thorough, practical education are necessary to its proper mastery and practice.

The rather fragmentary training in meat inspection which the student of veterinary science previously received during his course of study could not be considered as sufficient. Meat inspection had to become a separate subject of study, receiving special attention at the veterinary institutions, and this has been done in Germany, Austria-Hungary, France, Switzerland, England, America and Japan. "With reference to the importance and responsible position of veterinarians as technical officials in the realm of veterinary hygiene, it is the duty of the State, besides giving attention to the highest possible training of these men, to furnish special instruction in hygiene and the pathology of human food materials" (Bollinger). In this connection it is also greatly to be desired that the practical training of the future veterinarian in meat inspection should be obtained by a practical course of several months' duration at one of the larger abattoirs. The Imperial Würtemburg Regierung has officially recognized the necessity of such special training in so far as it requires for admission to the public examination in veterinary science, by which the chief official veterinarians are selected, proof of practice for a period of at least two months in one of the larger public slaughterhouses under regulated veterinary police control and in the inspection station of one of the larger cities for meat which is imported from foreign countries.* This example has been followed in Prussia and Saxony, as well as in the Grand Duchy of Hessen, in so far as meat

* By proclamation of the Imperial Würtemburg Ministry of the Interior, October 28, 1897, it is provided that candidates must have had practice in a city of at least 30,000 inhabitants, fulfilling all the prescribed requirements, and in the inspection station of such a city.

inspection is included among the examination subjects, at least for official veterinarians. It is hoped that a provision similar to that of Würtemburg will be made by the other Regierungen, not only for official veterinarians, but also for all veterinarians who are appointed as managers of public slaughterhouses.

The suggestion made by Melchers, that only those veterinarians should be appointed as managers of abattoirs who have passed through a preliminary service of at least one year at one of the larger abattoirs with modern equipment, and after the completion of this preliminary service have passed a special examination, deserves much consideration. The title, Sanitary Veterinarian, should be conferred upon such veterinarians. In the interest of the better training of veterinarians in the subject of meat inspection, the change in the examination requirements in Germany for veterinarians, as recommended by Schmaltz, is to be characterized as highly desirable. Schmaltz proposed that meat inspection be added to the first section of the examination as an obligatory subject of examination. At present only a part of the candidates in veterinary science in Germany are examined in meat inspection, and even this part only on theoretical subjects and not on practical ones. Such a test can not be considered as sufficient for a profession of such practical significance as meat inspection. In Hungary and in Switzerland meat inspection has already been made a theoretical and practical subject of examination in public veterinary examinations.

Special examinations for slaughterhouse veterinarians are already in existence in France. The Central Police Bureau of Paris makes the appointment of abattoir veterinarians depend upon the veterinary candidate passing an examination prepared by the Director of Meat Inspection in Paris. The examination is both written and oral; the written part includes a treatise on some subject in anatomy or pathology; the preparation of a report concerning the violation of the meat inspection law or other regulations. The practical part of the test falls into three sections: First, inspection of the meat of a diseased animal and diagnosis of the disease; secondly, determination of parts and organs of a body according to anatomical characteristics; and thirdly, microscopic examination of pathological alterations and parasitic diseases.

In the United States also special examinations have been introduced for veterinarians who are to be appointed as meat inspectors.

Compensation and Appointment.—In return for their difficult and responsible duties, veterinarians who are intrusted with the practice of meat control should receive a commensurate compensation. In southern Germany this is commonly too small, due to the fact that ideas of former times, in which the purchasing power of money was higher, are still prevalent. Furthermore, the fees for meat inspection should be paid to the meat inspectors by the municipal authorities, who should retain the right to collect the fees from the tradesmen. Finally, the attempt should be made to appoint the veterinarians who officiate at abattoirs as high communal officials for life and with right to a pension. For only under such circumstances can it be expected that the best veterinarians will devote themselves to abattoir service and will discharge their duties in the strictest manner, unbiassed by friendship or enmity. In a memorial of the Society of Abattoir Veterinarians of the Rhine Province presented to the Prussian lower house, attention was called to the fact that the interests of meat inspection, which coincide with those of the public, are frequently opposed to the interests of butchers who operate in the abattoirs, and that the butchers are only too strongly inclined to regard in a personal manner measures which the director of the abattoir must enforce in the interests of the public. Since, however, the butchers in small communities exercise an indirect or direct influence as tax-paying citizens upon the municipal corporation, the position of the director of an abattoir, who is not appointed permanently, frequently becomes very uncertain, if he discharges his duties in a conscientious manner.

Fees.—In the veterinary district of Oberfranken the fees for the inspection of a large animal before and after slaughter amount to 24 pfennige, and for a small animal, 12 pfennige. These rates were reasonable at a time when the meat which was inspected had but little value and was offered for sale at a few pfennige per pound.* In northern Germany the fees, corresponding to our

* According to a quotation from the cities of Berlin and Cologne for the year 1661, the price of meat was fixed at the following rates:

The best pound of beef	1 groschen
A pound of beef next to the best	11 pfennige
The poorest	10 pfennige
A pound of veal shall be worth	1 groschen 3 pfennige
A pound of fattened mutton	1 groschen 4 pfennige
A pound of pork, as low as	1 groschen 6 pfennige
The best and fattest pork, per pound	2 groschen

present money values, are much higher. Thus, for example, the meat inspection ordinance in Goch fixes the following rates: For one horse, 2 marks; for one beef animal, 2 marks; for one hog, 1 mark; for one sheep, goat or calf under ten weeks of age, .75 mark; for one-half of a large animal or smaller parts, 1 mark; for one-half of a small animal or smaller parts, two-thirds of the fee. For the Regierungsbezirk of Oppeln, the following fees were fixed: For a horse or beef animal, 1.5 marks; for a hog, except in case of trichina inspection, 1 mark; for a goat, sheep or calf under six weeks of age, 0 5 mark.

If the inspector of animals for the abattoir is at the same time meat inspector for the investigation of trichina, he receives a fee of $1\frac{1}{2}$ marks for the complete inspection of a hog.

Appointment of Abattoir Veterinarians.—Section 56[6], Title V, of the Prussian Municipal Order, prescribes as follows concerning municipal officers: "The appointment shall be made for life except in cases of mere temporary service. Subordinate officials who are occupied with mechanical work may be employed subject to removal."

Section 65, Title V, of the Municipal Order prescribes a pension allowance for municipal officials who are appointed for life. Accordingly, abattoir veterinarians must be appointed for life and with a pension allowance; as, for example, the Royal Prussian Regierung at Armsberg decreed August 2, 1888: "The director of an abattoir is a municipal official, since this position does not involve mechanical work or temporary service."

Moreover, according to a decision of the Prussian Court of Administration of November 20, 1881, abattoir veterinarians must be appointed for life and with a pension allowance, for the reason that, on the one hand, official authority is exercised (release or confiscation of the meat), and since, on the other hand, the occupation in which they engage does not belong to the industrial occupations or those which are established simply for securing an income for the city.

In the interest of the public, it is not to be considered as permissible that the city authorities should exclude the allowance of a pension for municipal officers who are appointed for life by conditions named in the contract of appointment.

(The opinion of the Prussian Court of Administration of Sept. 26, 1885; compare also Wysocki, Ztschr. f. Fleisch u. Milchhyg., Vol. 3; and the decision of Reichsgericht of Sept. 12, 1892.)

According to the new Prussian law concerning the appointment and maintenance of communal officials, every appointment must be made upon the basis of a written contract. The ordained administrative officers (Regierung presidents or state councillors) determine whether the communal authorities proceed with legal exactness in installing the official. In the appointment of officials, it is necessary to adhere to the principle that authoritative functions shall be exercised exclusively by officials, while the communities retain the right to accept in civil service persons who are exclusively occupied with the management of industrial affairs and are not empowered to act on behalf of the government. According to the text of the law and a ministerial commentary to the laws, abattoirs and stockyards, as a rule, belong to municipal industries. The officials of abattoirs and stockyards may therefore be appointed by notification by means of a private contract. This fact, however, does not exclude the possibility that official authority may be granted to certain persons appointed to service in these industries if they are to be allowed to exercise authority in the way of police regulations. The necessity for such an arrangement with regard to the foremen of abattoirs is recognized in the ministerial proclamation, for the reason that the order for the delivery of inferior meat to the freibank must be entrusted to them. Malkmus rightly contended that this necessity should also be recognized with regard to other abattoir veterinarians, for the reason that they must daily exercise police authority (confiscation of individual parts, preliminary confiscation of whole animals), if the reliability of meat inspection is not to be called in question. According to Oertel (Municipal Ordinance for the Six Eastern Provinces, 2d ed., Liegnitz, 1893), all abattoir veterinarians in Prussia belong to the higher municipal official class (compare Melchers, Ztschr. f. Fleisch u. Milchhyg., vol. 4). In order to avoid subsequent proceedings, it is desirable that the power of higher municipal officials should be conferred upon abattoir veterinarians, as well as a life-long appointment with provision for a pension. This may be accomplished by special contract before the acceptance of the position (see Bohlen, Zeit. f. Fleisch u. Milchhyg., vol. 4).

Number of hours of service.—The number of daily working hours for a responsible service of abattoir veterinarians should be confined within such limits that meat inspection may be always practiced in a reliable manner. (Compare the decree of the Royal

Bavarian Regierung of Rheinpfalz; also Ostertag, Zeit. f. Fleisch u. Milchhyg., vol. 4.)

The number of food animals which can be inspected in a day by an expert.—Henschel, on the basis of several years' experience in a Berlin abattoir, states that during one day's work a veterinarian at an abattoir may carefully inspect, before and after slaughter, 75 cattle, or 250 calves, or 200 hogs, or 400 sheep. In estimating the number of hogs, it is presupposed that in an inspection for cysticerci an assistant meat inspector (stamper or sampler) shall be on duty. In exceptional cases, the number of animals inspected may exceed the above figures by one-third or one-half.*

(B) Assistant Meat Inspectors.

Necessity for training and limitation of their functions.—The number of veterinarians in Germany is not sufficient to enable them to carry out the requirements of meat inspection without assistants. For the control of slaughtering in the country, assistant or empirical meat inspectors are to be appointed as their assistants, according to the method already put in practice with excellent results in southern Germany. The training of the assistants should have taken place at abattoirs under the direction of veterinarians. A theoretical training of the meat inspector is quite insufficient for his later duties, but an authority for rendering decisions commensurate with their limited information should be granted to empirical meat inspectors who have been educated in a practical manner. They should have the right of rendering decisions only in the case of perfectly healthy animals, or in cases of diseases which are perfectly evident. In all other cases of disease, and especially in emergency slaughter, the assistant meat inspectors should be required to obtain the decision of the local veterinarian through the instrumentality of the police officials. Furthermore, a fixed order of inspection must be obligatory upon assistant meat inspectors, in order that the actual determination of the diseases which occur in food animals may be made certain.

A principle proclaimed in Belgian and southern German ordinances is worthy of general approval. According to this principle, in communities in which there is a veterinarian, he is

* These figures are not applicable to the more systematic method of inspection practised in America.—Translator.

first to be called to make an inspection of meat, and exceptions can be taken to this rule only with the permission of the Regierung. The assistant meat inspectors are to be required to keep accounts of their operations. They are to be visited without previous notice as frequently as possible by official veterinarians on their inspecting trips, and are to be re-examined from time to time—say every two years. In order to increase the responsibility of the assistant meat inspectors, and also their authority with regard to tradesmen, they should be given an official character in the manner already practised in southern and middle German allied States where meat inspection is a regular institution. The salary of assistant meat inspectors, like that of scientific experts, should be provided for in proper manner by the communities.

With reference to the training of meat inspectors, the following opinion was handed down August 13, 1896, by the Royal Prussian Technical Deputation for Veterinary Service: "The simple theoretical knowledge of the contents of paragraphs of the regulations and provisions of the service are not sufficient evidence of the fitness of a layman (merchant) to practice the inspection of food animals. The inspector must be able to demonstrate in healthy and diseased living and dead animals that he actually possesses the knowledge which is presupposed in the regulations, and that he can make a practical application of it. Otherwise there would be the greatest danger that the meat inspector would allow meat which was dangerous to health to appear on the market." The ducal public veterinarian, Georges von Gotha, made the following arrangement, which is worthy of imitation. The assistant meat inspectors are assembled twice yearly by means of the bezirk veterinarians. At these meetings general reports are presented by the meat inspectors, and they receive further education through the discussion of noteworthy cases by the bezirk veterinarians.

The inadmissibility of the appointment of empirical meat inspectors in abattoirs.—Empiric meat inspectors have in some instances been appointed as superintendents of abattoirs in small, poor communities. This procedure is not to be approved. Only veterinarians should be appointed as directors of slaughterhouses. This is also in the interest of the communities. For, by the appointment of a veterinary director of an abattoir, the expenses are avoided which come from the inevitable veterinary revisions in the case of the empirical management of an abattoir, and this is true without taking into consideration the fact that the

veterinary director of an abattoir furnishes greater security for the proper execution of meat control than a lay director.*

A decree of the Royal Prussian Regierung President at Gumbinnen, August 11, 1896, prescribes that as a general rule only approved veterinarians shall be appointed as expert officials in public slaughterhouses in the sense of the Prussian abattoir law of March 11, 1869, and March 9, 1881, and that the inspection of food animals and meat shall be entrusted exclusively to them.

Indirectly, the compulsory appointment of veterinary directors of abattoirs was decreed in the Kingdom of Saxony by the regulation concerning the sale of the meat and fat of diseased animals, December 17, 1892. For, according to this regulation, the utilization of the meat of trichinous and tuberculous animals is permitted only in abattoirs which are under the supervision of veterinarians. In fact, the large number of tuberculous animals which may be utilized in this way serves as an inducement to larger communities in the kingdom to establish abattoirs and to appoint veterinary experts exclusively for their supervision.

Examination and control.—Examination and control of assistant meat inspectors, including trichina inspectors, should be in the hands of veterinarians. The physicians in northern Germany who in former years took part in the education and supervision of trichina inspectors, were not so well prepared for this duty by their course of study as are veterinarians. Steinbach justly contends that these functions should be exclusively entrusted to veterinarians, since it is usually a question of determining animal diseases, for which only the curriculum of veterinary science is calculated to prepare one. In recognition of this fact, the inspection of horse meat was everywhere put into the hands of veterinarians for veterinary police reasons. It is, therefore, merely a logical sequence that all other branches of meat inspection should be placed under the supervision of veterinarians, especially since the sanitary police interests which come into consideration possess no less importance than the veterinary police interests in the inspection of horse meat. It is gratifying to note that this conclusion is drawn in the new Prussian kreis-physician law. This law prescribes (Sections 79, 80) that "the supervision of the

* It is quite worthy of mention that the Brandenburg Butchers' Unions sent representatives to the Royal General President of the Province of Brandenburg to request that only veterinarians should be appointed as meat inspectors throughout the whole province, or at any rate in communities of more than 2,000 inhabitants.

traffic in meat, the establishment and management of slaughter-houses, are, so far as the technical side of the matter is concerned, primarily an affair of official veterinarians."

(c) Methods of Appeal.

In cases in which the tradesman is not satisfied with the decision of the meat inspector, he has the right to appeal to the judgment of a higher authority. In case of a decision by an assistant meat inspector, the higher decision lies within the province of the local veterinary expert. In other cases, in which recourse is sought against the decision of a veterinarian, the regulation of super-revision, in accordance with the Belgian law, is to be recommended (compare p. 33). Melchers proposes in this connection the following modifications of the method of appeal: The tradesman, within twenty-four hours at the outside limit, must appeal to the first expert and the authorities who are immediately over him, and must give the name of the expert whom he has chosen to give the contrary opinion. The latter individual is hereupon to be summoned by the authorities. If the judgment of the witness for the plaintiff agrees with that of the first expert, the decision as first rendered shall be enforced; while in case of a disagreement the matter may be dropped or a request for an opinion may be made upon the highest local veterinary authority. The highest veterinary authorities in Prussia are the Department veterinarians; in Bavaria, the kreis-veterinarians; and in other countries, the corresponding official veterinarians of high degree. Finally, in case of questions of fundamental importance, an appeal may be made to the court of last resort (the Veterinary Commission), which will decide the question according to the legal testimony.

It is unreasonable to assess the costs upon the tradesman under all conditions, as has happened in certain meat inspection regulations. The costs are justly to be defrayed by the losing party, and in case the opinions of the expert are set aside, the costs are to be borne by the community in which he is serving.

A police regulation for the Regierungsbezirk of Münster, dated May 7, 1897, prescribes with regard to this matter, "if the decision of the meat inspector is finally considered as unjust, the costs which are incurred by the owner in securing the higher opinion are to be borne by the local police authorities. The local police authorities likewise shall bear the costs when they make request for a final decision from these officials."

6.—Municipal Ordinances Concerning the Regulation of Meat Inspection.

In the interest of a uniform practice of meat inspection, imperial or state laws should be enacted concerning the control of meat traffic, with detailed specifications concerning the manner in which they are to be executed. Nothing is calculated to bring meat inspection into greater disrepute than a lack of uniformity in the practice of meat inspection in one and the same country. This becomes apparent whenever the regulation of meat inspection is left entirely in the hands of the provincial or Bezirk-Regierungen or of individual communities.

On account of the important position which meat from its varied nature occupies with regard to other food materials, it is not practicable to consider it in laws concerning food stuffs together with other food materials and condiments. It has become apparent in Germany that the legal provisions concerning food materials can not be applied in general to meat without doing violence to the construction of the law. Regard should therefore everywhere be had to the passage of special meat inspection laws.

In the imperial or state laws, it must be specified that all food animals are to be inspected before or after slaughter by veterinarians or assistant meat inspectors. Furthermore, the state laws must contain principles for directing the establishment of slaughterhouses and for the procedure with the meat of healthy and diseased animals. In regard to the latter question, they should particularly specify that the meat which is to be admitted freely to the market shall be stamped with a certain mark, and, furthermore, that meat which is excluded from the market shall be technically utilized in the proper manner, and, finally, that in certain diseases of food animals the meat, after cooking, pickling, or other suitable treatment, may be delivered to freibanks for sale under certain restrictions. In the meat inspection laws, the authority of the officials of meat inspection to make unannounced visits of inspection upon butchers should be regulated.

The provisions of state laws concerning the control of the traffic in meat are to be supplemented by stringent regulations for enforcing these laws. In these regulations the details should be carefully worked out concerning the appointment and compensation of expert meat inspectors, concerning the training, examination, control and subsequent examination of empirical meat inspectors;

concerning the order of super-revision; concerning the location and equipment of slaughterhouses, the establishment of freibanks, and the trade restrictions upon freibank meat, as well as concerning the disinfection of parts and whole animals which are absolutely excluded from use as food.

It is not desirable to make further specifications concerning the practice of meat inspection in the state laws and in the regulations for enforcing these laws. Thus, it would not be in accordance with the purpose of meat inspection to lay down principles concerning the sanitary police procedure with the meat of diseased animals. The scientific side of meat inspection is still in a developmental stage, and the investigations in this field are continually bringing to light new points of view with regard to the utilization of the meat of diseased animals. It is therefore desirable that the regulation of this part of meat inspection should be left to the ministerial authorities, who, supported by the opinions of scientific central authorities, may prescribe a procedure with the meat of diseased animals in accordance with the progress of the science of meat inspection at any given time. In this connection it is of great importance that the ministerial decree can go into effect much more quickly than a law which comes into existence after a long and tedious process and the passage of which does not depend exclusively upon scientific factors.

Summary.

The most essential requirements for the execution of obligatory meat inspection consist of the following measures: The establishment of public slaughterhouses and the introduction of compulsory slaughter in these institutions in all the larger communities; compulsory inspection for all food animals intended for human consumption, both before and after slaughter; ample encouragement of the science of meat inspection at the veterinary high schools; training and appointment of empirical meat inspectors with restricted powers to render decisions concerning diseased animals in country districts; veterinary supervision of all slaughtering which is done in abattoirs as well as all outside slaughtering in cases which can not be disposed of by the assistant meat inspectors. In addition to the special training of veterinarians in meat inspection in the curriculum provided for them, the introduction of a special course for abattoir and official veterinarians, the enactment of public laws concerning meat inspection with ex-

haustive provisions for their enforcement, especially laws concerning the uniform regulation of the traffic in unmarketable meat, as well as concerning the destruction or most advantageous technical utilization of the parts and whole animals which are absolutely excluded from use, should go hand in hand with the measures mentioned above.

These measures point to a goal which, on account of its importance to the public welfare, it should be the object of every civilized country to attain. When this goal is attained, the sanitary condition of the population will be improved, honest traffic in meat and meat products will be created, and, finally, a beginning will have been made in the improvement of the health of our domesticated animals which are at present so excessively parasitized and infected with disease.

The most important condition to the attainment of this goal is the education of industrious, reliable experts to whom the execution and supervision of meat inspection may be entrusted. The chief functions of practical meat inspection (careful investigation of all animals before and after slaughter, a most accurate determination of all variations from the normal condition, a scientifically and legally correct separation of marketable and nonmarketable meat, and the sanitary destruction of organs and whole animals which are excluded from use) are such important duties and so intimately connected with general sanitation and the national welfare as to make it evident that they should be undertaken only by thoroughly trained experts. A defective knowledge of the subject is most bitterly avenged in meat inspection. Either it allows meat dangerous to health to pass upon the market or causes a loss to the national resources by unjust condemnations.

II.

THE IMPERIAL LEGAL FOUNDATION FOR THE REGULATION OF TRAFFIC IN MEAT IN GERMANY.

All state laws, ministerial decrees, regulations of the governments and local police orders must, so far as exceptions are not expressly permitted, be confined within the bounds of the provisions of the imperial law. If the state laws, ministerial decrees, police regulations, municipal ordinances, etc., overstep the limits prescribed by the imperial law, they are legally ineffective and violations of them can not be punished by the criminal justices.

The foundation for the regulation of meat traffic in the German Empire is henceforth laid by the imperial law of June 3, 1900, concerning the inspection of food animals and meat. Moreover, in rendering opinions on the meat of diseased animals and in the organization of meat inspection, the other imperial laws, copies of which are given below, come into consideration, at least in a part of their provisions.

1.—The Imperial Law of June 3, 1900, Concerning the Inspection of Food Animals and Meat.*

SEC. 1. Cattle, swine, sheep, goats, horses and dogs, the meat of which is intended to be used as food for man, shall be subjected to an official inspection both before and after slaughter. By decision of the Federal Council, obligatory inspection may be extended to other food animals.

In case of emergency slaughter, the ante-mortem inspection may be omitted.

The following are to be considered as cases of emergency: When there is reason to fear that the animal may die before the arrival of the proper local inspector, or that the meat may become

* The translation of the imperial law as published in the Report of Bur. Anim. Ind. for 1900 has been followed with slight alterations.—TRANSLATOR.

materially reduced in value owing to aggravation of the diseased condition, or when, in consequence of an accident, the animal must be killed immediately.

SEC. 2. In the case of food animals the meat of which is intended to be used exclusively in the owner's own household, the ante-mortem inspection may be omitted whenever the animals do not present any signs of disease which would exclude the fitness of their meat as food; the post-mortem inspection also may be omitted whenever such indications of disease are likewise not revealed during the killing and dressing.

Traffic in meat the inspection of which has been omitted on the ground of Sec. 2, paragraph 1, is forbidden.

As "own household" in the sense of Sec. 2, paragraph 1, are not to be considered: The household of the barracks, hospitals, educational institutions, restaurants, prisons, almshouses and similar institutions, nor the household of the butchers, meat dealers, nor of hotels, saloons and restaurants.

SEC. 3. The federated governments are authorized to order the inspection, at places where and times when a communicable animal disease prevails, of all food animals exposed to said disease.

SEC. 4. Meats, in the sense of this law, are fresh or prepared parts of warm-blooded animals, so far as these parts are edible. Fats and sausages prepared from warm-blooded animals are also considered as "parts"; other products, however, only so far as the Federal Council orders.

SEC. 5. For the furtherance of inspection, districts shall be established; at least one inspector and one deputy inspector shall be appointed for each of such districts.

The establishment of the inspection districts and the appointment of the inspectors devolve upon the federated governmental authorities. For the inspections to be performed in the military preserved meat factories there may be special inspectors appointed by the military authorities.

Official recognized veterinarians, or other persons who have demonstrated a sufficient knowledge, are to be appointed as inspectors.

SEC. 6. If during the inspections there is shown the presence or the suspicion of a disease for which compulsory notification exists, action is to be taken in accordance with the regulations in force governing the case at hand.

SEC. 7. If the ante-mortem inspection does not furnish any ground for preventing slaughter, the inspector shall permit it to

take place under any special precautions which in his judgment should be adopted.

The slaughter of the animal presented for inspection shall not take place before permission is given, and then only under the special precautionary measures ordered.

If slaughter does not take place at latest two days after permission is given, then it shall be allowable only after a re-inspection and a second permit.

SEC. 8. If the post-mortem inspection shows no ground for the condemnation of the meat, the inspector shall declare it as fit for consumption by man.

Parts of a slaughtered animal shall not be taken away before inspection.

SEC. 9. If the inspection shows that the meat is unfit as food for man, then the inspector shall place a provisional embargo upon it, inform the owner of this fact, and shall immediately give notice to the police authorities.

Meat the unwholesomeness of which has been established by inspection shall not be brought into traffic as food or condiment for man.

The use of the meat for other purposes may be permitted by the police authorities, so far as sanitary considerations do not contraindicate. The police authorities shall determine what precautionary measures are to be adopted in order to prevent the use of such meats as food for man.

The meat shall not be brought into traffic without permission from the police, and then only under the precautionary measures prescribed by the police authorities.

The meat shall be disposed of by the police authorities in such manner that it can do no harm, so far as its use for other purposes [Sec. 9, paragraph 3] is not permitted.

SEC. 10. If the inspection shows that the meat is only conditionally fit as food for man, then the inspector shall place a provisional embargo upon it, shall inform the owner of this fact, and shall immediately give notice to the police authorities. The latter shall determine under what safeguarding measures the meat can be made fit for human food.

Meat which has thus been recognized as only conditionally utilizable shall not be brought into traffic as food and condiment for man before it has been made fit for human food by the safeguarding measures prescribed by the police authorities.

So far as such action of making the meat fit for food is not taken, the provisions of Sec. 9, paragraphs 3 to 5, shall apply.

SEC. 11. Dealing in meat thus made fit as food for man [Sec. 10, paragraph 1] can take place only under a designation making this condition recognizable.

Dealing in and use of such meat by meat dealers and hotel, saloon, and restaurant keepers are allowed only on license from the police authorities. This license shall be revocable at any time. Such meat shall be delivered to the above-mentioned tradespeople only so far as such a license has been granted to them. In the business rooms of these persons it must be made especially evident, by means of an intelligible sign in a conspicuous place, that meat of the quality designated in paragraph 1 [Sec. 11] is sold or used.

Meat dealers shall not offer for sale nor sell this quality of meat in the same rooms in which wholesome meat [Sec. 8] is offered for sale or sold.

The importation past the customs line of meat in hermetically sealed cans, or in other similar vessels, of sausages and other mixtures made from chopped meat, is prohibited.

As for all other meats, the following provisions relative to their importation past the customs line shall be in force until December 31, 1903:

1. Fresh meat may be imported past the customs line only in entire carcasses, but the carcasses of cattle (with the exception of calves) and of swine may be cut into halves.

The pleura and the peritoneum, lungs, heart, kidneys, and, in case of cows, the udder also, must be attached to the carcass in natural connection. The Federal Council is authorized to extend this provision to other organs.

2. Prepared meat may be imported only when from its origin and its preparation danger to human health is, as shown by experience, excluded, or when, at the time of importation, its harmlessness to human health can be determined in a reliable manner. This determination is to be considered impracticable, especially in shipments of pickled meat, when the weight of single pieces is less than four kilograms. This order does not apply to hams, bacon and casings.

Meat which, although subjected to a preserving process, has practically retained the properties of fresh meat, or which, through suitable treatment, can recover those properties, is not to be considered as prepared meat. Such meat comes under the provisions of number 1.

After December 31, 1903, the conditions governing the importation of meat are to be determined anew by law. If no new law is enacted by the time mentioned, the regulations established by Sec. 12, paragraph 2, shall remain in force until further measures are adopted.

SEC. 13. Meat passing the customs line shall be subject, upon its importation, to an official inspection, made with the coöperation of the customs authorities. Such meat as is proved to have already been inspected, according to regulations, in the inland, and meat intended for shipment in direct transit, is excepted herefrom.

The importation of meat shall take place only via certain customs houses. The Federal Council shall determine these customs houses, and also the customs and revenue offices where the inspection of the meat may take place.

SEC. 14. For game and fowls, and further, for meat carried for use on journeys, the provisions of Secs. 12 and 13 shall be applicable only so far as the Federal Council orders.

For meat imported in the minor frontier trade, as well as in the trade of the fairs and markets of frontier districts, exceptions to the regulations of Secs. 12 and 13 may be made by order of the federated governments.

SEC. 15. The Federal Council is authorized to decree more sweeping prohibitions and restrictions of importation than are provided in Secs. 12 and 13.

SEC. 16. The provisions of Sec. 8, paragraph 1, and of Secs. 9 to 11, apply also to meat imported inside of the customs line. Instead of the innocuous disposal or of the safeguarding measures ordered by the police, the re-exportation of the meat may, however, be permitted under corresponding precautionary measures, so far as hygienic considerations do not contraindicate.

SEC. 17. Meat which is not intended as food for man, but which can be so used, may be imported without inspection, after it has been rendered unfit for human food.

SEC. 18. The inspection (Sec. 1) of horses must be made by officially recognized veterinarians.

Dealing in horse meat, as well as the importation of such meat inside of the customs line, shall take place only under a designation, in the German language, which makes the meat recognizable as horse meat.

Dealing in and the use of horse meat shall be permitted to meat dealers and hotel, saloon and restaurant keepers only with a license from the police authorities; the license shall be revocable

at any time. Horse meat may be delivered to the above-named tradespeople only so far as such a license has been granted to them. In the business rooms of these persons it must be made especially evident, by means of an intelligible sign in a conspicuous place, that horse meat is dealt in or used.

Meat dealers shall not offer for sale nor sell horse meat in the same rooms in which meat from other animals is offered for sale or sold.

The Federal Council is authorized to order that the above regulations be applied to asses, mules, dogs and other animals which are more rarely slaughtered.

SEC. 19. The inspector shall clearly indicate upon the meat the result of the inspection. Meat imported from abroad is, in addition, to be plainly stamped as imported meat.

The Federal Council shall determine the kind of mark to be used.

SEC. 20. Meat which has been subjected within the German Empire to official inspection, according to Secs. 8 to 16, may be subject to an official reinspection only for the purpose of determining whether it has spoiled in the meantime, or whether it has otherwise suffered any change in its condition, rendering it injurious to health.

Enactments of the federated governments, according to which, for communities with public slaughterhouses, the dealing in fresh meat may be subjected to restrictions, especially to obligatory inspection within the community, shall remain unaffected, with the proviso that their applicability shall not be made dependent upon the origin of the meat.

SEC. 21. In the industrial preparation of meat no materials or processes shall be used which are capable of imparting to the wares a condition injurious to health. It is forbidden to import from abroad such prepared meat or to offer it for sale, to sell it, or otherwise to bring it into traffic.

The Federal Council shall determine the materials and the processes to which these regulations shall be applied.

The Federal Council shall order how far the regulations of paragraph 1 are applicable also to special materials and processes which are apt to conceal an unwholesome or inferior quality of the wares.

SEC. 22. The Federal Council is authorized:

1. To issue regulations relative to determining whether persons possess sufficient knowledge to act as meat inspectors.

2. To establish general principles, according to which the

inspection of food animals and meat is to be carried out, and for the further treatment of food animals and of meat in case they are not passed.

3. To make the necessary arrangements for carrying out the provisions of Sec. 12 and for determining the fees for the inspection of meat brought inside the customs line.

SEC. 23. The laws of the federated governments determine who has to bear the cost of the official inspection (Sec. 1). In all other matters, the necessary regulations for carrying out the law shall be issued by the governments of the federated states, so far as the Federal Council has not been declared competent, or in so far as the Federal Council makes no use of the authority conferred upon it by Sec. 22.

SEC. 24. Regulations of the federated governments in regard to trichina inspection and the dealing in and use of meat which, although fit as food for man, is considerably diminished in its nutritive and food value; further, regulations of the federated government establishing more extensive obligations than does this law relative to: (1) The animals to be subjected to inspection, (2) the carrying out of inspections by officially recognized veterinarians, (3) the dealing in rejected meat, or in meat of animals designated in Sec. 18, are permissible on the condition that their applicability shall not be made dependent upon the place of origin of the food animal or of the meat.

SEC. 25. The Federal Council shall determine how far the provisions of this law apply to meat imported into that part of the Empire situated outside of the customs line.

SEC. 26. Imprisonment in jail not exceeding six months and a fine not exceeding one thousand five hundred marks, or either of these penalties, shall be imposed upon:

1. Any person who knowingly acts in contravention of Sec. 9, paragraphs 2, 4; Sec. 10, paragraphs 2, 3; Sec. 12, paragraph 1; or Sec. 21, paragraphs 1, 2; or of a prohibition based upon Sec. 21, paragraph 3.

2. Any person who shall knowingly bring into traffic as food or condiment for man meat which has been imported contrary to the regulations of Sec. 12, paragraph 1, or meat which has been rendered unfit for human food according to Sec. 17.

3. Any person who shall fraudulently affix or alter the marks provided for in Sec. 19, or who shall knowingly offer for sale or sell meat on which the marks have been fraudulently affixed, altered, or removed.

Sec. 27. A fine not exceeding one hundred and fifty marks or imprisonment will be imposed upon:

1. Any person who through carelessness shall commit one of the acts designated in Sec. 26, numbers 1 and 2.

2. Any person who shall undertake to slaughter an animal before it has been subjected to the inspection prescribed in this law, or ordered on authority of Sec. 1, paragraph 1, sentence 2; Sec. 3; Sec. 18, paragraph 5; or Sec. 24.

3. Any person who shall bring meat into traffic before it has been subjected to the inspection prescribed in this law, or ordered on authority of Sec. 1, paragraph 1, sentence 2; Sec. 3; Sec. 4, paragraph 1; Sec. 18, paragraph 5; or Sec. 24.

4. Any person who shall act in contravention of Sec. 2, paragraph 2; Sec. 7, paragraphs 2, 3; Sec. 8, paragraph 2; Sec. 11; Sec. 12, paragraph 2; Sec. 13, paragraph 2; Sec. 18, paragraph 2 to 4; also, any person who shall contravene orders issued in accordance with Sec. 15, or Sec. 18, paragraph 5; or the regulations of the federated governments concerning the dealing in and the use of meat, issued on authority of Sec. 24.

Sec. 28. In the cases in Sec. 26, numbers 1 and 2, and in Sec. 27, number 1, the confiscation of the meat shall be ordered in addition to the penalty. In cases in Sec. 26, number 3, and Sec. 27, numbers 2 to 4, the seizure of the meat, or of the animal, may be ordered in addition to the penalty. In the case of confiscation, it is immaterial whether the object seized belongs to the condemned person or not.

If the prosecution or the condemnation of a given person is not possible, then the seizure may be ordered independently.

Sec. 29. The provisions of the law of May 14, 1879 (page 145, Reichsgesetzbl.), regarding the traffic in foods, condiments and articles of use, remain unchanged. The provisions of Sec. 16 of said law shall also be applicable to offences against the provisions of the present law.

Sec. 30. Those provisions of this law which relate to the adoption of the arrangements necessary for carrying out the law for the inspection of food animals and of meat shall take effect on the day of the promulgation of this law.

Furthermore, the time when the law goes into effect, either wholly or in part, shall be fixed by an imperial order with the assent of the Federal Council.

Remarks Concerning Meat Inspection Law.

(A) General.

The enactment of the bill concerning the introduction of the inspection of food animals and meat in the German Empire was not accomplished by a unanimous vote on the part of the Reichstag. Strangely enough, according to a statement of the State Secretary, Count Posadowsky, certain persons were opposed to the law from whom such opposition was not to be expected. It seemed to have been forgotten that the new meat inspection law had in the first place a hygienic purpose—the protection of the public health.

The State Secretary of the German Empire, in a noteworthy speech, characterized the high purpose of the meat inspection law and also the defects which were due to the resolutions of the majority of the Reichstag. The original draft of the law was not enacted in the hygienically complete form in which the Reichsregierung presented it to the Reichstag. The majority of the Reichstag, which remained deaf to the statements of experts, introduced regulations into the law which we must regret from a standpoint of hygiene. Nevertheless, the bill, which has now become a law, is a great hygienic fact, the effects of which will be beneficial to the consumer, producer and dealer in equal degree.

From the standpoint of hygiene, we must consider that slaughtering for one's own household, according to the provisions of the law, is not subject to obligatory inspection, and we are of the opinion that this exception is not in accordance with the well-known interests of the farmer. It is to be hoped, however, that the facultative meat inspection in slaughtering for one's own household, like facultative inspection for trichina in hogs slaughtered for home use, will pass over into obligatory inspection after the undesirability of the exception has become apparent from practice.

The majority in the Reichstag, furthermore, to the disadvantage of the farmer and consumer, struck out the obligatory provisions concerning the sale of inferior meat upon the freibank.

Moreover, from a hygienic standpoint, the admission of separate pieces of meat from foreign countries is to be characterized as a defect in the law, since the inspection of such pieces for the purpose of determining their harmlessness is an impossibility. It must be admitted, on the other hand, that the Reichstag, contrary to the original draft of the law, introduced a prohibitive order against the introduction of manufactured articles, such as sausages and con-

serves, the composition of which is entirely beyond control. Moreover, it is possible that in the introduction of separate pieces of meat a change for the better may occur when it becomes possible, by the admission of animals from foreign countries in abattoirs on the border, to enforce strictly the requirement that only whole parts of animals in their natural connections with the internal organs shall be introduced. Finally, some objections may be raised against the wording of Sec. 20, which permits cities to make a subsequent inspection of meat introduced from foreign countries only when it is in a fresh condition, as well as against the penalties which have created contradictions between the new law and the corresponding provisions of the food law and the criminal statutes for the German Empire.

It will be the duty of the Federal Council and the governments of the various federated States to regulate this matter by the decree of ordinances for enforcing the law.

The *rationale* of the law, together with technical commentaries on it, are found in Act 138 of the Reichstag, 10th Legislative Period, First Session, 1898-1899. Furthermore, with regard to the history of the origin of the law, Act 639 of the Reichstag, 10th Legislative Period, First Session, 1898-1899, is important as containing the report of the 15th Session, which was entrusted with making the draft of the law, and, finally, the stenographic reports of the Reichstag for the Sessions 67, 68, 162, 163, 164, 199, 200, and 201 of the above-mentioned legislative period. From these sources the following commentary is taken.*

(B) Commentary on the Different Provisions of the Meat Inspection Law.

Section 1.

Cattle, swine, sheep, goats, horses, and dogs, the meat of which is intended to be used as food for man, shall be subjected to an official inspection both before and after slaughter. By decision of the Federal Council, obligatory inspection may be extended to other food animals.

In case of emergency slaughter, the ante-mortem inspection may be omitted.

The following are to be considered as cases of emergency: When there is reason to fear that the animal may die before the arrival of the proper local inspector, or that the meat may become materially reduced in value owing to aggravation of the diseased condition, or when, in consequence of an accident, the animal must be killed immediately.

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* Compare also the Commentary of von Rohrscheidt, The Meat Inspection Law of June 3, 1900. Leipsic: 1900.

(a) Compulsory inspection is restricted to domesticated animals, although from a hygienic standpoint the regulation of traffic in birds, game, fish, amphibia, crustacea and mollusks would also be desirable. The control of the traffic in fowl, game, fish, etc., is so essentially different from the regulation of the traffic in other meats that it was not considered practicable to treat these different matters in one and the same law. The control of fowl, game and fish markets is, therefore, reserved for later municipal ordinances.

The fact that dogs were introduced in Sec. 1 is not in accordance with the original purpose of the law; for, according to this purpose, only those animals should be mentioned the meat of which is of value as a food material for large classes of the population.

(b) "*Food for man.*" A preliminary condition to obligatory inspection is the utilization of the animals as a human food material. Animals which are utilized as food for other animals (in menageries, piggeries and dog kennels), or are to be used for technical purposes, are excluded from inspection.

(c) "*Before and after slaughter.*" The provision that food animals are to be inspected also before slaughter takes account of the fact that, for a well-founded opinion of the fitness of meat for food, there is required not only an inspection of the slaughtered animals, but also an examination of the animals before slaughter.

The control of the market (extraordinary meat inspection, see p. 1), the regulation of which is an affair of the police administration, is independent of the inspection prescribed by the Imperial Meat Inspection Law.

(d) "*Emergency slaughter.*" In cases of emergency slaughter, inspection before slaughter must be omitted, for the reason that slaughter must necessarily take place so quickly that the long delay in waiting the arrival of an inspector might result in the death of the animal. A compensation for this omission is had in the more accurate, microscopical, bacteriological and chemical inspection of the meat and in the stricter judgment of it (admission as human food only in case no doubt exists regarding the nature of the disease which occasioned the emergency slaughter, and regarding the fitness of the meat for food). In order to prevent the illegal evasion of the inspection of food animals before slaughter, and in order to give the criminal justice facts for directing his judgment, the meaning of emergency slaughter is expressly declared by the Reichstag. In accordance with the law an emergency slaughter exists only when a diseased animal is to be slaughtered

simply for the reason that the prospect of recovery is slight or that the further maintenance of the animal may not be profitable.

Section 2.

In the case of food animals the meat of which is intended to be used exclusively in the owner's own household, the ante-mortem inspection may be omitted whenever the animals do not present any signs of disease which would exclude the fitness of their meat as food; the post-mortem inspection also may be omitted whenever such indications of disease are likewise not revealed during the killing and dressing.

Traffic in meat the inspection of which has been omitted on the ground of Sec. 2, paragraph 1, is forbidden.

As "own household" in the sense of Sec. 2, paragraph 1, are not to be considered: The household of the barracks, hospitals, educational institutions, restaurants, prisons, almshouses, and similar institutions, nor the household of the butchers, meat dealers, nor of hotel, saloon and restaurant keepers.

(a) *The fundamental significance of the determination of exceptions.* According to the provisions of the law, only a portion of the animals slaughtered for home consumption (sheep, goats, and calves and pigs under three months) were excluded from compulsory inspection, and then only so far as the animals showed no evidence of disease. By such a wording of the law, the requirements of sanitation and the principal desires of farmers in slaughtering for their own use will be satisfied to the same degree. The Reichstag Commission, however, extended the prescribed exceptions to Sec. 2 to include all slaughtering for home use, although the representatives of the various governments explained that meat inspection must be extended to all slaughtering for home use for the reason that sanitary protection should be furnished uniformly for all consumers, and for the further reason that the veterinary police take great interest in the inspection of animals slaughtered for home use, and the inspection of slaughtered animals for home use had justified itself wherever it had been introduced (Hessen-Nassau and the Kingdom of Saxony). The wording given by the Reichstag Commission to Sec. 2 may be a Greek gift to the farmers, to whom the broader construction was supposed to be an advantage. The legal decisions collected in the Imperial Health Office concerning the violations of the food law show that the farmers who slaughter for home use do not realize the responsibility which they assume in the utilization of the meat of animals not inspected by experts. The farmer does not know that in using in his own household meat injurious to health and of the injurious character of which he is not aware, he is guilty of a violation of Sec. 12 to 14 of the food law, since the traffic in injurious food material for which punishment is provided in these paragraphs means nothing more nor less than "to make accessible

to others for food." If even now criminal proceedings are frequently begun against farmers on the basis of the food law, they will probably be much more numerous after the introduction of compulsory meat inspection, for the reason that recognition of the value of meat inspection will be much more common than previously among consumers, and all meat which has not been inspected will be regarded with suspicion. The more discerning farmers have, therefore, urgently advised their fellow-farmers, for the sake of their own health and in order to avoid malignant denunciation by their servants, to yield the exception in favor of slaughter for home use and to place the responsibility for the utilization of meat slaughtered for home use upon an expert to be selected for this purpose.

With regard to the exception from compulsory inspection of hogs slaughtered for home use, it should be remembered that all cases of trichinosis which have occurred in Berlin since 1883 have been due to pork products sent from outside localities to private persons. These products in the place where the slaughtering was done were intended for home consumption and were therefore not required to be inspected for trichina.

The restrictive provision that animals which show evidence of the presence of a disease rendering the meat unfit for use must be inspected is not calculated to prevent all harm resulting from the consumption of meat which was not inspected because it was intended for private use. For this provision allows a wide play to individual opinions and the less scrupulous farmers will attempt to shirk their responsibility by a pretended ignorance of the symptoms in question.

Manifestly, stock owners are not prevented from voluntarily offering for inspection animals which are not subject to compulsory inspection. Furthermore, it is left to the different States through the regulations of Sec. 24, paragraph 1, to subject animals slaughtered for home use, throughout their territory in general or under certain conditions, to compulsory inspection.

(b) "*Owner's own household.*" "*Industrial utilization of meat.*" The meaning of "owner's own household" appears from the regulation of paragraph 3, *e contrario*. In the institutions mentioned in paragraph 3, exceptions to compulsory slaughter are not permissible, since in these cases a higher public concern exists for the health of those persons who are brought to these institutions or are doing busines in them. Slaughtering for home use, however, which may be carried out by the inmates of servants' quarters in these

institutions, is to be looked upon as other cases of slaughter for home consumption. The regulation with regard to the household of butchers is intended to prevent the sale, offering for sale, or other utilization of meat which ostensibly was intended for the private household of those persons, but was placed upon the market by an evasion of compulsory inspection. The tradesmen, also, who prepare or manipulate meat before its sale (sausage makers, conserve manufacturers, etc.), are to be considered as meat dealers.

Unfortunately, according to Sec. 2, only the industrial utilization of meat which has not been inspected is forbidden, and not the giving of it away gratis or incidentally (explanation of the State Secretary of the Interior at the 200th Session of the Reichstag). It was intended in this provision to allow farmers who had slaughtered too much meat for their own household an opportunity to dispose of the excess, despite the fact that it would have been more suitable to make the subsequent disposition of the surplus dependent upon the inspection of the meat. "The utilization is industrial only when it is undertaken and continued for the purpose of gain. A single instance of the utilization of the meat, is, therefore, not industrial if there is no intention of continuing in the business. On the other hand, the financial advantage does not necessarily consist in money." (Rohrscheidt, according to decisions of the Upper Tribunal Court, the Upper Administrative Court, Imperial Court, and the Court of Chancery.)

(c) "*Signs of disease which would exclude the fitness of their meat as food.*" In order that this restriction of Sec. 2 may have any practical value, it is necessary in the regulations for enforcing the law to specify those diseases which render meat unfit for use, and their symptoms. It must then be the business of the local authorities to make generally known these commentaries of Sec. 2 of the meat inspection law.

Section 3.

The federated governments are authorized to order the inspection, at places where and times when a communicable animal disease prevails, of all food animals exposed to said disease.

Sec. 3 is copied after a Bavarian meat inspection regulation in order to make possible the inspection of all food animals for the protection of the consumers and for the determination of the cases of disease in the interest of the veterinary police, at least during the prevalence of plagues (epizootic anthrax, swine erysipelas, swine plague, and hog cholera). Since in this instance it is a case of local

origin and temporary measures, the competency of the different Regierungen is conceded.

Section 4.

Meats, in the sense of this law, are fresh or prepared parts of warm-blooded animals, so far as these parts are edible. Fats and sausages prepared from warm-blooded animals are also considered as "parts"; other products, however, only so far as the Federal Council orders.

(a) "*Meat.*" The meaning of meat was not well defined. It was desirable, therefore, to define its limits accurately, chiefly for the purpose of establishing a precedent for the application of federal inspection to the various kinds of foreign meat. According to the definition given in the law, meat is to be considered as including all parts of warm-blooded animals in so far as they are suitable for human food. It is not required that they be also intended for this purpose. In the sense of Sec. 4, prepared and manufactured meat, sausages, fats, and intestines are also included under meat.

(b) "*Other products.*" These are, for example, meat extracts, meat peptones, meat gelatines, soup tablets, the necessity for the control of which before their admission to the food market had not made itself felt until the present time, as is asserted in the law. The Federal Council, however, shall have the right to subject all these other products to compulsory inspection in cases of emergency.

(c) "*Parts of warm-blooded animals.*" By means of this limitation the meat of fish, amphibia, crustacea, and mollusks is excluded, while that of fowls is included.

Section 5.

For the furtherance of inspection, districts shall be established; at least one inspector and one deputy inspector shall be appointed for each of such districts.

The establishment of the inspection districts and the appointment of the inspectors devolve upon the federated governmental authorities. For the inspections to be performed in the military preserved meat factories, there may be special inspectors appointed by the military authorities.

Officially recognized veterinarians, or other persons who have demonstrated a sufficient knowledge, are to be appointed as inspectors.

(a) *Inspection districts.* The establishment of inspection districts is necessary in order to control the execution of the provisions of the law. The boundaries of the districts depend upon local conditions. This matter was, therefore, left to local authorities.

(b) *Inspectors.* The original draft of the law read: "It is expedient that only veterinarians shall be appointed as inspectors. Other persons must submit to an examination before their appointment." By means of this wording, an attempt was made to give

expression to the view that in localities where veterinarians were to be obtained they should be appointed as inspectors and that other persons should be appointed only in localities where this supposition did not apply. The problem of inspection is regulated in this manner in the South German meat inspection ordinances and in the Belgian meat inspection law. This takes into consideration the fact that the best guaranty for expert practice of the inspection of food animals and meat is obtained when it is carried on by approved veterinarians. Practically, the final wording of Sec. 5 of the law does not change the intent of the original draft, since for reasons already given the supervisory authorities are to bear in mind the expediency of the appointment of veterinarians as inspectors.

The exclusive competency of approved veterinarians is provided for in the law only in the case of the inspection of horse meat (Sec. 18, paragraph 1). Furthermore, the Federal Council may call upon them for an inspection of animals which are more rarely brought to slaughter. Moreover, in Sec. 24, number 2, authority is given to limit in a legal manner the appointment of laymen as meat inspectors, or to exclude them entirely within the various federal States.

Aside from the investigation of horses, veterinary inspection is absolutely necessary in cases of emergency slaughter, for meat introduced from foreign countries, and for meat which after slaughter is found to exhibit important variations from the normal condition.

Sec. 22 gives the Federal Council the authority to make regulations concerning the proof of sufficient knowledge on the part of assistant meat inspectors, in order that it may not be lowered beyond a certain standard and in order that the training and examination of these persons may be regulated in a uniform manner throughout the German Empire.

The technical commentaries upon the original draft of the meat inspection law contain the following statement concerning the competency of the veterinarian for meat inspection.

For judging the healthy and diseased condition in the living and slaughtered animal, approved veterinarians are best adapted from their previous course of training and from their active duties in practice. In addition to the fundamental sciences of anatomy, pathology, pathological anatomy, bacteriology, parasitology, and animal industry, students in veterinary high schools receive special training in meat inspection. In the majority of States this branch of knowledge receives consideration in the examination for the posi-

tion of official veterinarian. In Würtemburg, admission to this examination is made to depend upon a practical course in one of the larger abattoirs. In other States the same condition may be required. Many veterinarians actively employed in public abattoirs have already chosen the special service of officials of the sanitary police as a life work and have made important contributions to the scientific foundation of meat inspection. It is, therefore, expedient that only approved veterinarians be appointed as meat inspectors. In cities in which veterinarians have located, this will nearly always be possible.

(c) *Special inspectors for the investigations to be undertaken in army conserve factories.* The desirability of the appointment of military veterinarians for the inspection of army conserve factories was questioned in the Commission of the Reichstag. On this point the representative of the Ministry of War remarked that horse doctors were approved veterinarians and that in the practice of their duties they had abundant opportunity to occupy themselves with meat inspection. Thus, for more than a year, the inspection of animals before and after slaughter, not only in army conserve factories, but also for all meat rations issued to troops, has been enforced. The inspection of food animals and meat in the maneuver abattoir is quite general.* Finally, it was asserted that the horse doctors had occasion to occupy themselves with this branch of the service with especial thoroughness on account of the fact that in all army corps special annual courses, partly theoretical and partly practical, were given under the direction of horse doctors, and in these courses the commissary officials and paymasters received instruction in meat inspection.

Section 6.

If during the inspections there is shown the presence or the suspicion of a disease, for which compulsory notification exists, action is to be taken in accordance with the regulations in force governing the case at hand.

The duty of notification. When it appears in making an inspection that a disease or the suspicion of a disease exists, of which, according to the Imperial or State law, it is necessary to give notice, the inspector and also the owner are required, according to the regulations, to give notice of this fact at the proper place. (Compare p.

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* According to the regulations of the army veterinary ordinances, the inspection of meat intended for the troops belongs to the duties of the horse doctors.

Section 7.

If the ante-mortem inspection does not furnish any ground for preventing slaughter, the inspector shall permit it to take place under any special precautions which in his judgment should be adopted.

The slaughter of the animal presented for inspection shall not take place before permission is given, and then only under the special precautionary measures ordered.

If slaughter does not take place, at latest two days after permission is given, then it shall be allowable only after a reinspection and a second permit.

(a) *Passing for slaughter.* The inspector shall have the authority to enforce certain measures concerning slaughter; for example, in order to prevent the dissemination of virus or contagion in the case of diseased or suspected animals, or in order to diagnose the disease more accurately, or to render more reliable the judgment concerning the fitness of the meat of the slaughtered animals for food. The passing of the animal may be made subject to the condition that the animal shall be slaughtered only in a particular room (in public abattoirs, in the so-called police slaughterhouse, see p. 39), or that slaughter shall take place without delay.

(b) That the permission to slaughter should become inoperative if it is not taken advantage of within two days after it is granted appears to be well founded from the fact that important alterations may occur in the general condition of the animal in the meantime, which would require a revocation of the permission or the issuance of special regulations. As a justification of the two-day period, the general principle may be cited from Section 199 of the Civil Processes and Section 187 of the Civil Statutes that in periods for which some event, or a point of time during the course of the day, constitutes the beginning, that day is not to be reckoned in which the event or the point of time falls. In addition to the day on which the permission for slaughter is granted, the two following days of the calendar are to be considered as belonging to the period.

Section 8.

If the post-mortem inspection shows no ground for the condemnation of the meat, the inspector shall declare it as fit for consumption by man.

Parts of a slaughtered animal shall not be taken away before the inspection.

Section 9.

If the inspection shows that the meat is unfit as food for man, then the inspector shall place a provisional embargo upon it, inform the owner of this fact, and shall immediately give notice to the police authorities.

Meat the unwholesomeness of which has been established by inspection shall not be brought into traffic as food or condiment for man.

The use of the meat for other purposes may be permitted by the police authorities, so far as sanitary considerations do not contraindicate. The police authorities

shall determine what precautionary measures are to be adopted in order to prevent the use of such meats as food for man.

The meat shall not be brought into traffic without permission from the police, and then only under the precautionary measures prescribed by the police authorities.

The meat shall be disposed of by the police authorities in such manner that it can do no harm, so far as its use for other purposes [Sec. 9, paragraph 3] is not permitted.

Section 10.

If the inspection shows that the meat is only conditionally fit as food for man, then the inspector shall place a provisional embargo upon it, shall inform the owner of this fact, and shall immediately give notice to the police authorities. The latter shall determine under what safeguarding measures the meat can be made fit for human food.

Meat which has thus been recognized as only conditionally utilizable shall not be brought into traffic as food and condiment for man before it has been made fit for human food by the safeguarding measures prescribed by the police authorities.

So far as such action of making the meat fit for food is not taken, the provisions of Sec. 9, paragraphs 3 to 5, shall apply.

Section 11.

Dealing in meat thus made fit as food for man [Sec. 10, paragraph 1] can take place only under a designation making this condition recognizable.

Dealing in and use of such meat by meat dealers and hotel, saloon and restaurant keepers are allowed only on license from the police authorities. This license shall be revocable at any time. Such meat shall be delivered to the above-mentioned tradespeople only so far as such a license has been granted to them. In the business rooms of these persons it must be made especially evident, by means of an intelligible sign in a conspicuous place, that meat of the quality designated in paragraph 1 [Sec. 11] is sold or used.

Meat dealers shall not offer for sale nor sell this quality of meat in the same rooms in which wholesome meat is offered for sale or sold.

(a) *Results of the investigation and judgment of meat with reference to its fitness for food.* The Imperial Meat Inspection Law distinguishes between three fundamentally different classes of meat with reference to their fitness for food: (1) Meat which is fit for food (Sec. 8); (2) meat which is unfit for food (Sec. 9); (3) meat which is qualifiedly fit for food (Sec. 10).

The original draft of the law characterizes, as a fourth kind of meat, such as is of inferior value (meat which is fit for human food but which is very inferior in its nutritive value). The Reichstag, however, for reasons which are absolutely unintelligible, rejected the regulation by Imperial law of traffic in meat of inferior value and the introduction of freibanks which is directly connected with it, and without which a proper practice of meat inspection is unthinkable, and left the promulgation of suitable regulations to the different governments. The only persons who could be oppo-

nents of the regulation of the traffic in inferior meat and of freibanks are farmers, and they only from ignorance of the real conditions. Since, however, freibanks are already authoritatively introduced in southern Germany, middle Germany, and the Kingdom of Saxony, and since the representatives of the Prussian Agricultural Chamber, in harmony with the German Agricultural Council, declared in favor of the introduction of freibanks,* it is to be assumed that in the Kingdom of Prussia as well as in other parts of Germany the freibank question will be regulated by means of state laws.

(b) "*Meat which is fit for food, meat which is unfit for food and meat which is qualifiedly fit for food.*" The term "meat which is fit for food" is synonymous with "marketable" of the older meat inspection laws, and, according to the provisions of the original draft of the law, included meat "which is of normal quality and which gives rise to no suspicion with regard to its wholesomeness." This definition is not entirely clear, and, moreover, is not sufficient, for meat of normal appearance can not give rise to any suspicion as to its wholesomeness. On the other hand, however, we must reckon in this class such meat as shows only unimportant variations from the normal; for instance, a very slight degree of icterus.

The term "unfit for food," according to the provisions of the law, includes meat which, on account of the danger to human health connected with its use as food, must be absolutely excluded from utilization as a food material. This definition is also unsatisfactory, for we may have meat which, without being dangerous to health, is unfit for human food; for example, watery, strong smelling, highly discolored, meat infested with numerous harmless parasites, etc. That the law makers intended to have these defects considered as a sufficient ground for a declaration of unfitness for food is apparent from the technical commentaries to the laws, in which meat from acute cases of swine plague, swine erysipelas, trichinosis, measles, poisoning, dropsy, wasting diseases, etc., is declared to belong to the class "unfit for food."

Meat is held to be qualifiedly fit for food when it is not utilizable as human food in its natural condition without injuring health, but which may have lost its dangerous properties by suitable treatment; for example, measly or trichinous meat, and also the meat in certain forms of tuberculosis.

* Report concerning the Proceedings of a Conference Instituted by the Central Authority for Animal Industry of the Prussian Agricultural Chamber for the preparation of an Obligatory Insurance Law for Food Animals in Prussia. Berlin: 1901.

Furthermore, although it was not mentioned in the text of the law or in the technical commentaries, all meat belongs to this class which comes from such diseases as may be disseminated through meat traffic; for example, swine erysipelas, swine plague, and hog cholera.

With reference to the classification of defective meat, the text of the law declares that characters, by which the proper classification of meat in one or the other of the groups mentioned is determined, can not be mentioned in an exhaustive manner on account of the great differences which are observed in the appearance of meat in general. The decision must rather be reached independently in each case. The desired uniformity of classification will, therefore, be sufficiently assured by the fact that the Federal Council established certain guiding principles for the judgment of meat, for which authority is given in Sec. 22, paragraph 2.

(c) *Method of procedure in the case of defective meat.* While meat which is fit for food is not subject to any restriction in traffic, meat which is unfit for food may never be admitted to sale as food or condiment for human beings, and meat which is qualifiedly fit for food may thus be admitted only after it has been made utilizable by boiling, steaming, pickling, or refrigerating. For other purposes, as for technical utilization (the preparation of oils, soaps, and candles) for feeding animals and the like, the utilization of the meat may be permitted by the police authorities in so far as no sanitary scruples exist. Measures for assuring the proper procedure in rendering meat which is qualifiedly fit for food suitable for use, for the purpose of preventing the utilization of dangerous meat as human food, may be found in the regulations of the police authorities; for example, the denaturalization of the meat by the assistants or deputies of the police. The certainty of proper treatment may, however, be secured by police requirements upon the owners of the meat, the fulfillment of which is controlled officially. In the case of meat which is unfit for human food, it will be necessary, as a rule, to take care that it is not admitted to the market before it is rendered externally unfit for human consumption. The choice of means for securing this result is left to the discretion of the police authorities, according to the regulations of the Federal Council based upon the principles contained in Sec. 22, paragraph 2. The owner does not have the right to require that the meat shall be delivered to him for applying the necessary treatment; for example, cooking of measly or trichinous pork. In so far as admission of meat which is unfit for food for other purposes than for human

food appears to be undesirable, the police authorities are to provide for its harmless disposal (burying, burning, etc.). It is not unconditionally required that they themselves or their deputies should undertake this destruction; it may, under certain conditions, suffice if the proper disposal of the meat is made under their immediate supervision and according to regulations which they have adopted. If the required treatment of meat which is qualifiedly fit for food is omitted, it is to be considered as unfit for food.

(d) *Condemnation and notice of condemnation to the police authorities.* In the case of condemnation, the duty of the meat inspector, aside from notifying the owner and the police authorities, is restricted to taking charge of the meat for the purpose of preventing its secret removal or illegal utilization. Further measures (such as the harmless disposal of meat which is unfit for food, its condemnation for technical utilization, determination of procedure for rendering suitable for food meat which was qualifiedly fit for consumption) are entrusted to the local police authorities. The final decision concerning condemned meat is, therefore, rendered not by the meat inspector, but by the police authorities. The extent to which the police authorities are bound by the judgment of the meat inspector, concerning the quality of the meat and the manner in which the owner of the slaughtered animal may be granted the privilege of contesting the condemnation of the meat, is to be regulated by authority of the various governments (Sec. 23). The transfer of police authority to the abattoir directors, as was stated during the sessions of the Commission, is not in accordance with the Imperial law with regard to the conditions of the local police authorities and the administrative arrangements in the different States. In Saxony and Würtemburg, police powers are conferred upon some of the abattoir directors.

In case of slaughter and inspection of a large number of animals in abattoirs and similar institutions, special notice need not be given to the police authorities for each separate animal. It appears to be much more satisfactory to make a general report for several, say for all the animals condemned during one day.

(e) *Limitations of traffic in meat which is qualifiedly fit for food, but which has been rendered utilizable.* Meat which has been rendered suitable for food by any process whatever is still defective. The provisions contained in the section are, therefore, necessary in order to prevent the sale of this meat, as if it were without defect and saleable for the same price as meat of prime quality.

Section 12.

The importation past the customs line of meat in hermetically sealed cans, or in other similar vessels, of sausages and other mixtures made from chopped meat, is prohibited.

As for all other meats, the following provisions relative to their importation past the customs line shall be in force until December 31, 1903:

1. Fresh meat may be imported past the customs line only in entire carcasses, but the carcasses of cattle (with the exception of calves) and of swine may be cut into halves.

The pleura and the peritoneum, lungs, heart, kidneys and, in case of cows, the udder also, must be attached to the carcass in natural connection. The Federal Council is authorized to extend this provision to other organs.

2. Prepared meat may be imported only when from its origin and its preparation danger to human health is, as shown by experience, excluded, or when, at the time of importation, its harmlessness to human health can be determined in a reliable manner. This determination is to be considered impracticable, especially in shipments of pickled meat, when the weight of single pieces is less than four kilograms. This order does not apply to hams, bacon, and casings.

Meat which, although subjected to a preserving process, has practically retained the properties of fresh meat, or which, through suitable treatment, can recover those properties, is not to be considered as prepared meat. Such meat comes under the provisions of number 1.

After December 31, 1903, the conditions governing the importation of meat are to be determined anew by law. If no new law is enacted by the time mentioned, the regulations established by Sec. 12, paragraph 2, shall remain in force until further measures are adopted.

(a) *Prohibition of the introduction of canned meats, sausages, and other mixtures of minced meat.* This prohibition is the natural consequence of the execution of the law in the interior, since canned meats, sausages, and other mixtures made of minced meat can not be accurately tested with regard to their fitness for food.

(b) "*Whole animal bodies.*" The meaning of whole animal bodies requires a more detailed definition. According to the wording of Sec. 4, the trunk, together with the parts of the extremities and head, which are meat, are to be understood as included under the term animal bodies.

(c) *The introduction of certain organs in their natural connection.* The number of organs which, according to Sec. 12, are to be introduced in their natural connection is not sufficient for the purpose of rendering accurate judgment on meat. It is desirable, also, that the uterus in female animals, and it is necessary that the spleen in all food animals (diagnosis of anthrax and Texas fever), as well as the head of cattle (cysticercus) and horses (glanders), in case it is not reckoned with the animal bodies, should also be introduced. In the case of the horse, the skin in its natural connection is also required for the diagnosis of glanders.

(d) *Introduction of prepared meat.* The provisions concerning the introduction of prepared meat are to be considered as the result of a compromise which is technically not well founded; for in individual pieces of prepared meat, even when their weight amounts to more than 4 kg., the harmlessness of the meat can not be determined in a reliable manner; take, for example, anthrax, septicemia, and generalized tuberculosis; even the dangerous animal parasites (cysticerci and trichina) are only accidentally demonstrable in individual pieces. Thus it happens that by the customary methods of preparation (pickling, salting, and smoking) the harmful properties of meat are either not destroyed at all or at least not with certainty.

According to the compromise, the following forms of prepared meat are for the present permitted to be introduced: pieces of pickled meat of a weight of more than 4 kg., beef livers under the same conditions, and also hams, bacon sides, and intestines.

Section 13.

Meat passing the customs line shall be subject, upon its importation, to an official inspection made with the coöperation of the customs authorities. Such meat as is proved to have already been inspected, according to regulations, in the inland, and meat intended for shipment in direct transit is excepted herefrom.

The importation of meat shall take place only via certain customs houses. The Federal Council shall determine these customs houses and also the customs and revenue offices where the inspection of the meat may take place.

(a) *Foreign meat.* All meat in the sense of Sec. 4 is subject to a compulsory inspection. Therefore, not only the meat of animals which, according to the law or according to local regulations provided for therein, are subject to inspection, but also the meat of all warm-blooded animals so far as exceptions are not made in the law. Compulsory inspection applies also in the same manner to meat which is intended for private use as to that which is intended for general utilization.

(b) The "*customs inland*" is not co-extensive with the boundaries of the German Empire.

To the German customs inland belong also Luxemburg and the customs ports lying in the Austrian regions. The free harbor regions, on the contrary, do not belong to the customs inland.

(c) *Coöperation of the customs officials.* The coöperation of the customs officials is confined to making possible the immediate seizure of all meat introduced for sanitary inspection and to prevent the meat from being freely admitted to the market before a satisfactory decision on the inspection is reached.

Section 14.

For game and fowls, and, further, for meat carried for use on journeys, the provisions of Secs. 12 and 13 shall be applicable only so far as the Federal Council orders.

For meat imported in the minor frontier trade, as well as in the trade of the fairs and markets of frontier districts, exceptions to the regulations of Secs. 12 and 13 may be made by order of the federated governments.

The exception from compulsory inspection of wild game and fowls, as well as all meat which is transported for use in travelling. The draft of the law states on this point that the necessity of a sanitary control in general does not exist for wild game and the meat of fowls. Occasionally, to be sure, in outbreaks of epizootics among game and fowl in foreign countries, a method of control may be shown to be necessary. In the case of meat which is carried for use on journeys and also in the case of meat which is ordered from foreign countries by post, it appears that so long as no especially dangerous conditions exist the practice of an official inspection may be omitted. On the one hand, the quantities of meat which come into consideration in this connection are, as a rule, inconsiderable, and are not for subsequent sale, but for private use of the persons concerned. On the other hand, again, the inspection of these materials would be connected with great inconvenience on the part of the owners and recipients. The original draft of the law, therefore, gave authority to the Federal Council to determine according to requirements in how far an inspection of meat of these classes should be undertaken.

Section 15.

The Federal Council is authorized to decree more sweeping prohibitions and restrictions of importation than are provided in Secs. 12 and 13.

Further prohibitions and restrictions concerning the introduction of meat are provided in case of the possibility that in the future new meat preparations which can not be inspected might be introduced.

Section 18.

The inspection (Sec. 1) of horses must be made by officially recognized veterinarians.

Dealing in horse meat, as well as the importation of such meat inside of the customs line, shall take place only under a designation in the German language which makes the meat recognizable as horse meat.

Dealing in and the use of horse meat shall be permitted to meat dealers and hotel, saloon, and restaurant keepers only with a license from the police authorities; the license shall be revocable at any time. Horse meat may be delivered to the

above-named tradespeople only so far as such a license has been granted to them. In the business rooms of these persons it must be made especially evident, by means of an intelligible sign in a conspicuous place, that horse meat is dealt in or used.

Meat dealers shall not offer for sale nor sell horse meat in the same rooms in which meat from other animals is offered for sale or sold.

The Federal Council is authorized to order that the above regulations be applied to asses, mules, dogs, and other animals which are more rarely slaughtered.

(a) *Exclusive competency of veterinarians for the inspection of horses.* The inspection of horses must be performed by approved veterinarians, since the recognition of glanders and the formation of judgment on the fitness for food of horse meat requires a mass of technical information such as is usually not possessed by assistant inspectors.

(b) The requirement of a declaration for horse meat is justified by the inferior market value which horse meat possesses as compared with beef and other kinds of meat and by the antipathy which many people feel against the consumption of horse meat. For similar reasons, declaration is indicated for the meat of other solipeds and dogs, as well as for the meat of goats and buffaloes.

Section 20.

Meat which has been subjected within the German Empire to the official inspection according to Secs. 8 to 16, may be made subject to an official reinspection only for the purpose of determining whether it has spoiled in the meantime, or whether it has otherwise suffered any change in its condition, rendering it injurious to health.

Enactments of the federated governments, according to which, for communities with public slaughterhouses, the dealing in fresh meat may be subjected to restrictions, especially to obligatory inspection within the community, shall remain unaffected, with the proviso that their applicability shall not be made dependent upon the origin of the meat.

(a) *Repeated official inspection.* The text of the law declares that the previously customary repeated inspection of meat which has already been inspected inland has given rise to many complaints on account of the expenses and other inconveniences which are connected with it. Such a repeated inspection will be dispensed with for the future, for every inspection carried out according to the provisions of the Imperial law will be regarded as binding upon the entire Empire. This holds good especially for the inspection which is provided for foreign meat. The law proceeds, therefore, upon the principle that in general a single inspection is sufficient and must be binding upon the entire Empire. This principle, however, requires certain qualifications. In the first place, reinspection must be prompt in so far as it is a question of determining whether

changes have occurred (since the performance of the inspection) which may make the meat unfit for use. The draft of the law, therefore, provided that in the latter case a re-inspection should be permitted. Moreover, it is apparent that the general control of food materials, which is based on the food law, shall not be abrogated in the case of meat which is inspected according to the provisions of the law. The requirement in Sec. 29 leaves no doubt on this point. This control, moreover, is indispensable, since otherwise it can not be determined whether the meat which is brought to the market has ever been inspected and whether it bears the stamp required in Sec. 19 as evidence of inspection, as well as for the purpose of preventing the offering for sale of spoiled meat or meat which has subsequently become unfit for use in any other way; for example, meat treated with injurious preserving re-agents. A general secondary inspection can no longer be ordered by the local authorities. On the other hand, the authority of the police to undertake subsequent official inspection remains unaffected in individual instances, especially in case of suspicion of violation of the provisions of meat inspection or of failure of the meat inspector to perform his duty, as well as from reasons of public sanitation. The same holds good for subsequent tests which may be required when in a particular case doubt may be entertained concerning the findings of the meat inspector and concerning decision regarding the fitness of the meat for food.

(b) *Especial provisions for communities with public abattoirs.* According to the Prussian Slaughterhouse Law, it may be ordered, in communities which have erected a public slaughterhouse, that no meat which is not slaughtered in a public abattoir can be offered for sale within the district until it is subjected to an inspection by expert inspectors for a fee which is returned to the communal treasury. This provision, which includes a secondary inspection of meat introduced from outside localities, removes to a certain extent the scruples which might be entertained with regard to provision of Sec. 20, paragraph 1. Considered from a purely theoretical standpoint, the latter provision is correct. From the practical aspects of the affair, however, the authority for repeated complete inspection should not be excluded. The annual reports of the municipal meat inspection at Berlin offer convincing proof that it is absolutely necessary to subject introduced meat to a complete subsequent inspection, even when it has been already inspected elsewhere, before it is admitted to the market at the point of introduction. In order to give a single example, trichinæ are

almost annually found in hogs which were inspected at the place of slaughter and were admitted to the market as apparently free from trichina. Exactly the same conditions prevail in other cities. On the basis of similar experiences it is provided in the Grand Duchy of Baden, which at the present time possesses the best organization of meat inspection inside of the German Empire, that all meat introduced from one part of Baden into another shall be again carefully inspected before it is offered for sale in the second locality and shall be certified by the meat inspector. The repetition of the inspection of meat which is transported from one inspection district into another must be considered as absolutely necessary, since it furnishes the only effective means of preventing evasions of meat inspection, false stamping, and defective inspection. Without special provisions in favor of communities with public abattoirs, the system of meat inspection hereby established would be compelled to take a step backward. The same undesirable conditions would be brought about which were fortunately obviated in the Kingdom of Prussia in the year 1887 by the amendment to the slaughterhouse law.

Section 21.

In the industrial preparation of meat no materials or processes shall be used which are capable of imparting to the wares a condition injurious to health. It is forbidden to import from abroad such prepared meat or to offer it for sale, to sell it, or otherwise to bring it into traffic.

The Federal Council shall determine the materials and the processes to which these regulations shall be applied.

The Federal Council shall order how far the regulations of paragraph 1 are applicable also to special materials and processes which are apt to conceal an unwholesome or inferior quality of the wares.

Harmful preserving materials and stuffs which are calculated to conceal the dangerous or inferior character of the products. By means of the prohibition of the use of the above mentioned materials, which is to be expected in regulations issued by the Federal Council, all uncertainty which had been caused by divergent opinions of experts concerning permission for the addition of boric, salicylic, and sulphurous acids, and coloring materials to meat and meat products, are removed.

Section 22.

The Federal Council is authorized:

1. To issue regulations relative to determining whether persons possess sufficient knowledge to act as meat inspectors.

2. To establish general principles, according to which the inspection of food

animals and of meat is to be carried out, and for the further treatment of food animals and of meat in case they are not passed.

3. To make the necessary arrangements for carrying out the provisions of Sec. 12 and for determining the fees for the inspection of meat brought inside the customs line.

By the fact that the authority mentioned in Sec. 22 is reserved for the Federal Council, uniformity in the execution of meat inspection is assured.

Section 23.

The laws of the federated governments determine who has to bear the cost of the official inspection (Sec. 1). In all other matters, the necessary regulations for carrying out the law shall be issued by the governments of the federated States, so far as the Federal Council has not been declared competent or in so far as the Federal Council makes no use of the authority conferred upon it by Sec. 22.

"*The laws of the federated governments.*" According to the commentary of Rohrscheidt in the report of the commission, it is not necessary that the provisions in question should be embodied in a law. This may be accomplished by means of ordinances. The particular federal State concerned decides whether a law is necessary or not. It is not prescribed in the Imperial law for the individual States which method of procedure they shall choose.

Section 24.

Regulations of the federated governments in regard to trichina inspection and the dealing in and use of meat which, although fit as food for man, is considerably diminished in its nutritive and food value; further, regulations of the federated governments establishing more extensive obligations than does this law relative to: (1) The animals to be subjected to inspection, (2) the carrying out of the inspections by officially recognized veterinarians, (3) the dealing in rejected meat or in meat of animals designated in Sec. 18, are permissible on the condition that their applicability shall not be made dependent upon the place of origin of the food animal or of the meat.

(a) *Provisions by decree of individual States concerning trichina inspection.* Sec. 24 furnishes the means of introducing a general trichina inspection and, therefore, also for hogs which are slaughtered for use in the household of the owner.

(b) *Meat of inferior value.* Meat of inferior value requires the same trade restrictions as meat which was qualifiedly fit for use, but has been rendered utilizable as food for man. (Compare p. 81.) Through Sec. 24 it is made possible for the authorities of the individual States to regulate traffic in meat of inferior value by suitable provisions.

(c) *Further provisions with reference to the animals which are to be subject to inspection and to the execution of meat inspection by approved*

veterinarians. In general the law must determine the minimum requirements which must be fulfilled throughout the Empire with reference to the inspection of food animals and meat. While it remains within the province of the individual federal States to issue further more detailed regulations for their territory in so far as the necessity exists, it is plainly indicated, as in the interest of the most effective preservation of the uniformity of the law, to set certain limits in this connection to the legislation of the individual States. For this purpose in Sec. 24 those points are separately brought out to which the authority of the federal States shall be limited. According to Sec. 1, the extension of compulsory inspection may be increased in two directions; viz., by extension to other animals than those mentioned in Sec. 1 or declared by the Federal Council as subject to inspection; and again by removal or a restriction of the inspection in favor of slaughtering for home use provided for in Sec. 2.

According to Sec. 2, it is permissible to limit the appointment of laymen as meat inspectors and to entrust the execution of inspection exclusively to approved veterinarians to a greater extent than the draft of Sec. 18, paragraphs 1 and 5, provided; and this holds good for certain kinds of animals or for animals suspected of being diseased or for meat which from its appearance awakens sanitary scruples.

Section 25.

The Federal Council shall determine how far the provisions of this law apply to meat imported into that part of the Empire situated outside of the customs line.

Localities outside of the customs line. In localities outside the customs line, the regulations of the law do not apply immediately. The fact that particularly in the regions of the free ports we have to do frequently with a mere exchange with foreign countries makes a considerable number of measures provided in the law appear inapplicable in such States, or at any rate unnecessary. The requirement of introduction of regulations of the law will differ in various regions outside of the customs line according to local conditions. The introduction of a regulation having regard to this point in the law would, however, meet with difficulties. The determination, therefore, of how far the provisions of the law shall be binding for localities outside of the customs line is left to the authority of the Federal Council.

Section 26.

Imprisonment in jail not exceeding six months and a fine not exceeding one thousand five hundred marks, or either of these penalties, shall be imposed upon—

1. Any person who knowingly acts in contravention of Sec. 9, paragraphs 2, 4; Sec. 10, paragraphs 2, 3; Sec. 12, paragraph 1; or Sec. 21, paragraphs 1, 2; or of a prohibition based upon Sec. 21, paragraph 3.

2. Any person who shall knowingly bring into traffic as food or condiment for man meat which has been imported contrary to the regulations of Sec. 12, paragraph 1, or meat which has been rendered unfit for human food according to Sec. 17.

3. Any person who shall fraudulently affix or alter the marks provided for in Sec. 19, or who shall knowingly offer for sale or sell meat on which the marks have been fraudulently affixed, altered, or removed.

Section 27.

A fine not exceeding one hundred and fifty marks or imprisonment will be imposed upon—

1. Any person who through carelessness shall commit one of the acts designated in Sec. 26, numbers 1 and 2.

2. Any person who shall undertake to slaughter an animal before it has been subjected to the inspection prescribed in this law, or ordered on authority of Sec. 1, paragraph 1, sentence 2; Sec. 3; Sec. 18, paragraph 5; or Sec. 24.

3. Any person who shall bring into traffic meat before it has been subjected to the inspection prescribed in this law, or ordered on authority of Sec. 1, paragraph 1, sentence 2; Sec. 3; Sec. 14, paragraph 1; Sec. 18, paragraph 5; or Sec. 24.

Section 28.

In the cases in Sec. 26, numbers 1 and 2, and in Sec. 27, number 1, the confiscation of the meat shall be ordered in addition to the penalty. In cases in Sec. 26, number 3, and Sec. 27, numbers 2 to 4, the seizure of the meat, or of the animal, may be ordered in addition to the penalty. In the case of confiscation, it is immaterial whether the object seized belongs to the condemned person or not.

If the prosecution or the condemnation of a given person is not possible, then the seizure may be ordered independently.

Penal provisions. With reference to the penalties provided in Sec. 26, paragraph 3 (the fraudulent use or fraudulent changing of the stamps of the kind mentioned in Sec. 19), the draft of the law states that the provisions of the criminal statutes are not sufficient to cover cases of the fraudulent use of these marks or the fraudulent changing of them as such, as well as the offering for sale or sale of meat from which the stamps have been removed. Moreover, cases of intentional offering for sale or sale of meat on which the stamp has been fraudulently placed or fraudently changed would, as a rule, be punished as forgery according to the general provisions of Sec. 270 or Secs. 267 and 268 of the criminal law. The application of these provisions, however, would lead to undoubted hardships on account of the severity of the punishments provided by these laws. It appeared to be proper, therefore, to establish a special penal provision in this case and to provide merely the punishment required for violations of the law for all cases which come into consideration in this connection, since in the first place they are

violations of purely police control measures. Otherwise, the provisions of the criminal law shall remain unaffected.

The provision of Sec. 28, paragraph 1, according to which in cases mentioned in Sec. 26, paragraphs 1 and 2, and Sec. 27, paragraph 1, procedure shall be instituted for seizure, is justified by the especially dangerous character of the meat which is presupposed in these cases. In other cases the seizure of the meat is left to the discretion of the court.

Section 29.

The provisions of the law of May 14, 1879 (page 145, Reichsgesetzbl.), regarding the traffic in foods, condiments and articles of use, remain unchanged. The provisions of Sec. 16 of said law shall also be applicable to offences against the provisions of the present law.

Further validity of the food law. For the avoidance of uncertainty, it was expressly stated in the law that the regulations of the food law (see p. 95) should remain unaffected. The provision of Sec. 29 is made with reference to the favorable effects which, according to past experience, have been produced by the public announcement of condemnations in the execution of the food law and its amendments.

Those provisions of this law which relate to the adoption of the arrangements necessary for carrying out the law for the inspection of food animals and of meat shall take effect on the day of the promulgation of this law.

Section 30.

Those provisions of this law which relate to the adoption of the arrangements necessary for carrying out the law for the inspection of food animals and of meat shall take effect on the day of the promulgation of this law.

Furthermore, the time when the law goes into effect, either wholly or in part, shall be fixed by an imperial order with the assent of the Federal Council.

Enforcement of the various provisions of the law. For the execution of the general inspection of food animals and meat, as was provided for in the law, detailed administrative measures, especially the creation of the machinery for carrying out inspection and of a personnel of inspection competent to carry out their functions, are required. While, therefore, on the one hand, it appeared to be necessary that all those provisions of the law which had reference to the establishment of these institutions should at once become operative, consideration must be had in determining the time for putting into force the other provisions of the law to secure a sufficient period of time for these preparations. It was not desirable

that this period should be determined in the law itself, since it could not be foreseen with certainty what length of time would be required for these preparations by the Imperial government and by the individual federal States. According to the precedent of other Imperial laws, the determination of the time for putting into force the requirements in question was reserved for an Imperial proclamation with the consent of the Federal Council.

2.—Imperial Law Concerning Traffic in Food, Condiments, and Manufactured Articles, of May 14, 1879.

Sec. 1. Traffic in food and condiments, as well as in playthings, tapestry, colors, eating, drinking, and cooking utensils, and in petroleum, is subject to inspection, according to the provisions of this law.

Sec. 2. Police authorities are empowered to enter places in in which articles of the sort mentioned in Sec. 1 are offered for sale, during the usual business hours, or while the places are open for traffic. They are empowered to take samples at their discretion of articles of the sort mentioned in Sec. 1 which they find in the places in question or which are offered for sale in public places, and to give a receipt for the same, after which the articles are to be inspected. Upon request, a part of the sample may be officially closed, sealed, and left with the owner. A recompense at the rate of the usual selling price is to be made for the sample which is taken if the inspection shows that the material is utilizable.

Sec. 3. The police authorities are empowered in case of persons who are condemned to confinement on the basis of Secs. 10, 12, and 13 of this law, to undertake inspection at such a time as is described in Sec. 2 in places in which articles of the sort mentioned in Sec. 1 are offered for sale or which serve for the preservation or preparation of such articles for sale. This authority begins at the time when judgment is pronounced and ends after the lapse of three years reckoned from the day on which the sentence was completed, shortened, or annulled.

Sec. 4. The competency of the authorities and officials with regard to the measures described in Secs. 2 and 3 is determined in accordance with regulations made by the government concerned. State regulations which give the police further authority than is mentioned in Secs. 2 and 3 remain unaffected.*

* This holds true especially with regard to the unannounced inspection of storerooms and factories by meat inspectors in Southern Germany, which inspection is

SEC. 5. Regulations may be made for the whole Empire by Imperial decree with the consent of the Federal Council for the protection of health, prohibiting:

1. Certain methods of preservation and packing of food and condiments which are intended for sale.

2. The public sale or offering for sale of food and condiments of a certain character or under claim of a quality which really does not belong to them.

3. The sale or offering for sale for the purpose of slaughter of animals which are suffering from certain diseases, as well as the sale or offering for sale of the meat of animals which were affected with certain diseases.

4. The utilization of certain materials and coloring matters for the preparation of clothing, playthings, tapestry, eating, drinking, and cooking utensils, as well as the public sale or offering for sale of articles which were prepared in a manner contrary to this prohibition.

5. The public sale or offering for sale of petroleum of a certain character.

SEC. 6. By means of an Imperial decree with the consent of the Federal Council, the preparation, sale, and offering for sale of

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ordered for all butchers. The meat inspectors of Southern Germany are required to perform not only the prescribed inspection of stock yards and slaughterhouses, but also the stalls and workrooms, as well as the rooms of the butchers, including their cellars, ice chests, sleeping rooms for the assistants, and also the sales rooms and store rooms of all persons engaged in meat traffic. This inspection takes place at least every two weeks, and inspection without notice is made, as a rule, each week of the premises of dealers in wild game, fowl, and fish, for the purpose of determining the cleanliness and other observations of the police regulations concerning the traffic in meat, etc., and, in case conditions are not found to be in accordance with the law, the required procedure is to be taken without delay.

Without such inspection smuggling in uninspected meat, the manufacture of sausages, and the cleanliness of the butcher's premises can not be controlled. Unannounced inspection of the sales room and work rooms of butchers make, therefore, a necessary supplement to true meat inspection, *i.e.*, the inspection of food animals before and after slaughter.

The Imperial Government President in Kassel, with regard to Secs. 2 and 3 of the food law, ordered the district veterinarians of his district on December 27, 1892, to make use of the authority which belonged to them as officials of the veterinary police, to undertake inspection of places open for traffic, and to take samples for inspection. The local police authorities are ordered immediately after notification by the court officials to communicate to the district veterinarians of the Kassel district the names of such persons as have been condemned to confinement on the basis of Secs. 10, 12, and 13 of the food law. According to the regulations concerning industrial pursuits, entrance into the work rooms of butchers is at all times permitted to police officials.

articles which are intended for the adulteration of food and condiments may be forbidden or restricted within the limits of the Empire.

SEC. 7. Imperial decrees issued on the basis of Secs. 5 and 6 are to be immediately laid before the Reichstag, if in session, otherwise at its next session. They may be annulled by order of the Reichstag.

SEC. 8. All persons who violate decrees issued according to Secs. 5 and 6 are to be punished with a fine of 150 marks or by imprisonment. State regulations can not provide a more severe punishment.

SEC. 9. All persons who, contrary to the provisions of Secs. 2 to 4, refuse permission to enter or to take samples or to make inspection are to be punished with a fine of from 50 to 100 marks or with imprisonment.

SEC. 10. Imprisonment not exceeding six months and a fine not exceeding 1,500 marks, or either, is provided for (1) all persons who imitate or adulterate food and condiments for the purpose of deception, in business and traffic in them; (2) all persons who knowingly sell food or condiments which are fraudulent imitations, or adulterated, and without stating this fact, or who offer them for sale under a deceptive label. If the actions mentioned in Sec. 10, number 2, are performed from carelessness, the punishment is a fine not exceeding 150 marks or imprisonment.

SEC. 12. Imprisonment, together with the possible loss of civil rights, is provided for (1) all persons who purposely prepare articles which are intended to serve as food or condiment for others in such a manner that they may be injurious to human health, and for all persons who knowingly sell, offer for sale, or otherwise traffic in as food or condiments articles the consumption of which would be injurious to human health; (2) all persons who purposely prepare clothing materials, playthings, tapestry, eating, drinking and cooking utensils, or petroleum in such a manner that the intended or future use of these articles is likely to be injurious to human health; and also all persons who knowingly sell, offer for sale, or otherwise have traffic in such articles.

Attempted evasions are punishable.

If on account of these forbidden actions a serious bodily injury or death of a human being is caused, the punishment is confinement in the workhouse for five years.

SEC. 13. If in cases mentioned in Sec. 12 the consumption or use of the article was likely to injure human health, and if this fact

was known to the vendor, the punishment is confinement in the workhouse for ten years; and if by the action in question the death of a human being is caused, confinement in the workhouse for not less than ten years or for life. In addition to the punishment, police supervision must be permitted.

SEC. 14. If any one of the actions characterized in Secs. 12 or 13 are performed through carelessness, the punishment is a fine not exceeding 1,000 marks or imprisonment not exceeding six months; and if through the action in question an injury is caused to the health of a human being, the punishment is imprisonment for one year, or, if the death of a human being was caused, imprisonment for from one month to three years.

SEC. 15. In the cases mentioned in Secs. 12 to 14, in addition to the punishment, those articles which were prepared, sold, offered for sale, or otherwise brought into trade in a manner contrary to the above mentioned regulations may be seized without regard to whether they belong to the condemned person or not. In the cases mentioned in Secs. 8, 10, and 11, the articles may also be seized. If in cases mentioned in Secs. 12 to 14 the prosecution or conviction of a certain person is not possible, the articles may rightly be seized.

SEC. 16. In rendering judgment or announcing punishment it may be ordered that the conviction shall be publicly announced at the expense of the guilty person. At the request of the acquitted defendant, the court must order the public announcement of the acquittal. The State Treasury bears the expenses in so far as they are not imposed upon the plaintiff. The manner of making the announcement is to be determined in the order.

SEC. 17. If there exists in the locality where the deed was committed a public institution for the technical investigation of foods and condiments, the fines which are imposed on the basis of this law, in so far as they belong to the State, are to be returned to the Treasury, which bears the cost of the administration of the institution.

AMENDMENT TO THE LAW CONCERNING FOOD, CONDIMENTS, AND MANUFACTURED ARTICLES, OF JUNE 29, 1887.

By the amendment of June 29, 1887, Sec. 16 of the law of May 14, 1879, receives the following additional provision: Whenever a legal conviction takes place in consequence of the police inspection of articles of the sort mentioned in Sec. 1, the costs of the police inspection must be borne by the convicted party. They are to be

determined at the same time with the costs of the legal procedure and to be collected.

Notes on the Law of May 14, 1879.

(a) General.

Until the passage of the Imperial Meat Inspection Law, the food law was the only means for applying Imperial law to the control of meat traffic. It had become apparent, however, that the peculiar nature of meat rendered it impossible that the offering for sale and sale of meat could be regulated by the general provisions concerning the whole subject of traffic in food materials. It is necessary also to consider another fact which rendered impossible a thorough meat inspection on the basis of the food law, namely, the want of regulations for executing the Imperial law of May 14, 1879. Finally, in this law no account was taken of the experience which had been had in the practice of meat inspection in southern Germany before the passage of the law. This is particularly apparent from the fact that the food law did not expressly provide for traffic in defective (spoiled) meat upon the freibank. This defect was disagreeably felt in the practice of meat inspection.

The food law, the provisions of which are not abrogated by the Imperial Meat Inspection Law (see p. 94), has, since the enforcement of the latter law, the value of a supplementary law, and remains for the future the legal foundation for criminal procedure in traffic with "spoiled, imitated, adulterated, and injurious" meat. The sources which are drawn upon in explaining the provisions of the food law are the material elaborated in the Imperial Health Office for a technical foundation of the food law, the report of the Reichstag Commission, and the proceedings of the Reichstag in connection with the draft of the law.* Meyer and Finkelnburg called attention to the fact that in explaining the food law we must consider not only the decisions of the courts, but especially those of the Imperial Court which have reference to the punishments provided in Secs. 10 to 16 of the law and which are of great value in making a commentary on them. "For although a complete retrial of the facts established in the trial court in a particular case may not be indicated for the Imperial Court by the nature of the legal procedure under revision, it nevertheless has an opportunity, in making a review for the purpose of determining to what extent

* Compare Meyer and Finkelnburg, Commentaries upon the Law of May 14, 1879.

actual error appears to have been committed, to express an opinion concerning the meaning of the provisions of the law, and to indicate clearly their application."

The decisions of the Imperial Court have given an explanation of special provisions of the law, especially the concept "spoiled," which differ essentially from those contained in the materials for the technical foundation of the law.*

(B) Special Notes on Secs. 10 to 14 of the Food Law,

Partly according to the commentaries of Meyer and Finkelnburg and partly according to later decisions of the Imperial Court concerning the application of the paragraphs cited from the Law of May 14, 1879.

Section 10.

Imprisonment not exceeding six months and a fine not exceeding 1,500 marks, or either, is provided for (1) all persons who imitate or adulterate food and condiments for the purpose of deception in business and traffic in them; (2) all persons who knowingly sell food or condiments which are fraudulent, imitations, or adulterated, and without stating this fact, or who offer them for sale under a deceptive label. If the actions mentioned in Sec. 10, number 2, are performed from carelessness, the punishment is a fine not exceeding 150 marks or imprisonment.

(a) "*For the purpose of deception*," "*without mentioning the fact*," and "*under a deceptive label.*" The actual status of the misdemeanor for which punishment is provided in Sec. 10 differs from that of Deception (Sec. 263 of the Criminal Law Statute) in that for its fulfilment neither the "intention of obtaining illegitimate profit for one's self or for a third person," nor the creation of an erroneous impression "by the representation of false conditions or by the suppression or covering up of true conditions" need be present. The violation of Sec. 10, however, may be a case of deception.

According to Sec. 10, it is only necessary that the act be calculated to deceive others or that it be done with the knowledge

* The Royal Prussian Ministers for Traffic, Industries, Interior, etc., explained to the representatives of several trades in the decree of September 14, 1883, that the explanation of Sec. 10 could not be based exclusively on the "materials" of the law, which proceeded upon quite different views from those of traffic and industry. It was further stated that the government presidents should instruct the police officials under them that they should have regard in all doubtful cases to the interests of trade and traffic in preparing a legal prosecution for adulterations of food and condiments. It was held, however, that it was not the purpose of the law to limit the legal and police prosecution to actually dangerous adulterations. The judical officers were given similar instructions by the Minister of Justice.

that it is calculated to deceive. According to the intention of the law the vendor must do all within his power to make clear to intending purchasers the true character of the wares. If the dealer knows that the wares are spoiled, imitations, or adulterated, he must state this expressly or must otherwise make it apparent. From this text it is plain that the law of May 14, 1879, was not intended to prohibit absolutely the sale of adulterated or spoiled food materials or imitations, but, as already indicated by Schmidt-Mülheim, it was intended simply to introduce a compulsory declaration for such food materials.

In case of an effected sale, it is sufficient that silence was maintained concerning the special character of the wares. In offering for sale it is not impossible that the vendor may make a truthful statement to the intending purchaser. On this account punishment is provided expressly for offering for sale "under a deceptive label," but not for offering for sale in general. "The determining factor is, however, deception concerning the character of the materials, not concerning their value; both will occur simultaneously in most cases, but not necessarily." (von Schwarze.)

By the term "offering for sale" is to be understood the intention of selling a thing in general and the making known of this intention, even if but one person is present. It is erroneous to assume that the article in being offered for sale must be made accessible to the public for purchase (opinion of the Imperial Court, IV, Criminal Senate, July 7, 1887). The mere opening of a store before the beginning of business hours does not constitute an offering for sale of the meat which is contained in the store (Decision III, of January 14, 1886).

Silence concerning the spoiled condition of meat which has been sold does not presuppose a suppression of the true conditions (compare Deception). On the other hand, the spoiled condition, when known to both vendor and vendee, must not be concealed (Decision IV, of October 1, 1886). In harmony with this statement the Imperial Court handed down a decision September 29, 1894, "if, on the other hand, the defendant knew that the purchaser recognized the wares as spoiled when she bought them, calling attention expressly to this defect would have been a useless formality which could not have had any influence either upon the knowledge or the intention of the purchaser."

(b) *Imitations.* Under imitations is understood "the preparation of a food material purposely in a way so that it appears to be different from what it is in reality" (Decision I, of May 15, 1882).

In the case which served as a basis for the opinion just cited, so-called schwartenmagen, contrary to the custom of the locality where the case was tried, was not prepared from blood, chopped meat, bacon rind, and bacon of hogs, but was made of two-thirds sinews and tripe and one-third blood, with a little fat.

The preparation of tongue sausage without tongue must also be characterized as an imitation of food material; similarly, the preparation of sausage from dog meat, since the making of sausage from this meat, which does not pass in ordinary traffic as a food material, gives the product the appearance of a food material which is suitable for man. (Decision II, of May 5, 1891.)

(c) *Adulteration.* According to Meyer and Finkelnburg, the attempt to make a legal definition for the concept "adulteration" was abandoned by the Reichstag and the explanation of the term was left to legal practice and science. Since, however, the essential part of a violation of Sec. 10 consists in the act of deception, the question of adulteration can only be answered on the basis of the normal methods of preparation and manufacture. These differ, as is well known, in different regions.

Thus, for example, the addition of a small quantity of wheat flour to Rostbratwurst (10 to 12 pounds of flour to 5 kg. of meat) is no adulteration, if to the people in the region in question such an addition is "in no way an unknown or unexpected admixture;" for, on the contrary, "flour belongs to a savory bratwurst according to popular opinion." (Decision III, December 21, 1882.)

Under adulterated food materials, we understand such as do not possess those qualities which are to be expected in actual traffic. The adulteration of a food material may be accomplished in two ways: (1) By substantial deterioration; (2) by furnishing a material with the appearance of a better quality.

The addition of a dough made of potato starch and water to sausages, contrary to the usual method of preparing sausages in a given place, according to which only pure meat sausages were understood as passing under the label in question, is an adulteration. (Decision I, of October 4, 1883.)

Coloring the gills of fish by means of a red stain, so as to give them the appearance of fresh fish, is an adulteration (Decision II, of December 2, 1881). Likewise the coloring of sausages with dye stuff in order to preserve the color of fresh material for a period during which without this manipulation they would have shown by the alteration of the natural color that they were not fresh, is an adulteration (Decision III, of February 18, 1882).

An undoubted case of adulteration is the coloring of old meat in order to lend it the appearance of fresh meat, and finally, the coloring of a sausage, consisting for the most part of paste, in order to give it the appearance of a meat sausage, is a double adulteration.

The existence of an adulteration is not excluded by the fact that the person concerned intended to give the food or condiment the appearance of a better quality for the purpose of deception, but actually brought about only a deterioration of the product. (Decision I, of February 28, 1887.)

(d) *Food condiments which are "spoiled."* The punishments which are provided for trafficking in "spoiled" food materials were, until the passage of the Imperial Meat Inspection Law, the most important basis for the regulation of traffic in meat which was not dangerous to health but which showed certain defects. This much-discussed term still possesses practical significance, since "spoiled" meat is declared to be meat of an inferior value, concerning the traffic in which regulations were unfortunately not included in the Imperial Meat Inspection Law.

The definition of the term "spoiled" has been the subject of a large number of decisions by the Imperial Court. At first, after the passage of the law of May 14, 1879, these opinions were based on quite other points of view than the later opinions. The Imperial Court at first declared food materials or condiments to be spoiled when they were not in a normal condition or when they varied from a normal condition to such a degree that they were not suitable for human food according to popular opinion. This definition corresponds to that of the term "spoiled in the sense of Sec. 367[7] of the Criminal Law Statute," which forbade the sale of "spoiled" meat in general and was, therefore, based on the assumption that such meat was not fit for human food. Sec. 10, paragraph 2, of the food law, however, differs in one important point from Sec. 367[7] of the Criminal Law Statute, since the former does not prohibit the sale or offering for sale absolutely, but only when these transactions are made without stating the real character of the food material or with the practice of deception concerning the same. Logically, therefore, the sale of meat which the food law characterizes as "spoiled" must be permitted without punishment if the sale takes place under a statement of the particular character of the article. By far the greater number of the decisions of the Imperial Court has considered as spoiled food materials those which vary from the normal condition and which are less suitable and utilizable for a given purpose, and also such as in and of themselves are not fit to serve

as food materials, but which, in consequence of peculiar properties, were either not to be sold at all, if the true character was known, or, at least, would not bring the price which is asked for material of a normal origin. Accordingly, the concept "spoiled" may be defined as follows: In the sense of the food law all meat is spoiled which, without being dangerous to health, shows considerable alterations of its substance, or comes from animals which were affected with serious diseases.

In this explanation I believe I have provided a positive basis for the determination of meat which—and this is the main point in question—must be excluded from free traffic, but which can be admitted to restricted sale on the freibank. The word "may" is to be emphasized, since the spoiled condition may reach such a degree that the meat loses its character as a food material, becomes meat "unfit" for use, in the sense of the Imperial Meat Inspection Law, and is, therefore, to be excluded even from restricted sale. The concept spoiled meat is synonymous with that of inferior meat, since all meat which can be sold as spoiled is rendered of inferior value on account of the necessity of its express characterization as such. Declared meat can find purchasers only when sold at a lower price.

Against my definition of the concept "spoiled" objection may perhaps be made that the expression "serious disease," of which I make use, is too poorly defined to furnish assurances of a uniform action. This objection, however, does not apply. The expert meat inspector must, by reason of his scientific training, be able to judge what, from the standpoint of sanitary police (not from a therapeutic standpoint), must be considered as a serious disease. For example, we may characterize as serious diseases of food animals, all acute and part of the chronic infectious diseases. In the majority of them the meat is not dangerous to health, but only "spoiled in the sense of the food law," as, for example, in pleuro-pneumonia, hemorrhagic septicemia, swine erysipelas, swine plague, and hog cholera. The conditions are similar in the case of other diseases which frequently give occasion for emergency slaughter (for example, parturient paralysis, traumatic pericarditis, etc.) In all these cases, in addition to the origin of the meat from animals which were seriously diseased, we must also consider that the meat differs objectively from normal meat which is accepted in ordinary business traffic, in so far as, in consequence of incomplete bleeding, it possesses poor keeping qualities and an associated inferior value. Such meat is suitable neither for preservation nor for the manufacture of sausages, but

must be eaten soon or it will begin to decompose. For this reason, in the sale of such meat, it is desirable that the special character of the wares should be made known to the purchaser.*

Since pathological processes in the animal body do not take place in a schematic manner, it is evident that there must be cases upon the boundary line between "serious" and "not serious." These cases must be left to the discretion of the expert inspector. They may be confidently intrusted to such persons, since they are rare and since the chief problem consists in separating the decidedly "serious" from the decidedly "not serious," and this, according to past experience, is not a difficult matter.

Noteworthy Decisions of the Imperial Court Concerning "Spoiled" in the Sense of Section 10[2] of the Food Law.

According to a decision of the First Criminal Senate of the Imperial Court, of October 5, 1881, the variation from the normal is the decisive point in spoiled food materials in the sense of the law of May 14, 1879; and, in determining the normal, the common condition which is looked for by the purchasers or the public with reference to the character of the wares is decisive. An internal chemical decomposition is not necessary to the concept "spoiled." The deterioration may consist in a quantitative change of the constituents, as is the case, for example, in meat which is infested with harmless parasites, or such as have been rendered harmless. (Decision III, of October 5, 1881.)

A food material is spoiled also if it is checked in its normal development. The normal condition in such cases has never existed, but it was expected to occur, as, for example, in the meat of unborn calves. (Decision II, of January 3, 1882.)

The meat of diseased, or dead, as well as of emaciated animals is spoiled if the anomalous character of the meat was due to a disease which brought about a serious alteration of its constituents with reference to the fitness of the meat for human food. (Decisions I, of January 12, 1882, and III, of July 9, 1883.)

An article is spoiled when its consumption creates disgust, not in the case of this or that individual person, according to their

* The previous connection of meat with diseased parts is not sufficient in itself to fulfil the conception of spoiled meat. (Compare decision of the First Criminal Senate of the Imperial Court, page 112, and Ströse, Ztschr. f. Milch und Fleisch Hyg. vol. 4. In harmony with this decision are the opinions contained in the most recent decrees concerning tuberculosis, that the meat of animals affected with localized tuberculosis may be admitted for sale without restriction, after the removal of the diseased parts.

particular taste, but according to the general opinion, or according to the opinion of that class of the population to which the intending purchasers belong. From this point of view it is not considered legally erroneous to look upon the fat of a measly hog as spoiled, even if it is not established that cysticerci have existed in the manipulated portions of the fat. In such cases we proceed on the theory that such fat, even if in and of itself it is not fit for food, is, nevertheless, in consequence of the antipathy or disgust experienced with regard to such material by the public, either never bought with a knowledge of its true condition or at least does not bring a price which would be offered for meat of a normal origin (Decision II, of March 25, 1884).

Disgust which exists merely in the imagination of the consumers without any objective foundation deserves no consideration. Only the quality of a food material which occasions objective disgust is sufficient to fulfil the conception of a spoiled condition. The previous connection of meat with disgusting parts does not in itself constitute the required objective foundation. "Some account is to be taken of the views of the public. The Court of Justice, however, was of the opinion that in a concrete case, dealing with persons who obtain their meat from the knackers, the assumption of disgust on the part of these buyers, who could not expect to receive a perfect quality of meat, is not justified. It is, therefore, not justifiable, in cases where mere previous connection of the meat with disgusting meat has been sufficiently considered according to the facts in the case, to look upon the parts which have lately been separated and sold as disgusting or even as spoiled" (Decision I, 1894).

The simple opinion of the public that a food material is of inferior value or less fit for food, while it remains possible that such material in reality possesses the same food value and the same fitness for food as normal meat, is not sufficient for the assumption of a "spoiled" quality. So far as the opinion of the public is to be considered at all, it may be decided only in connection with the objective quality of the food material, whereby an effect is actually produced which is calculated to influence badly its utilization as food (Decision III., of September 28, 1885).

The same decision contained also the opinion that it is necessary for satisfying the required conditions that the spoiled character be present at the time of the sale. A spoiled character of meat in the sense of Section 10[2] of the law of May 14, 1879, is also to be assumed when the variations from the normal character are due to

a disease which was present before slaughter and which was associated with the diminution of the value of the meat and the production of the feeling of disgust in the general public (Decision IV, of November 2, 1886). This was a case of the sale of a cow which had been slaughtered while diseased. The internal organs and interior surface of the ribs, but not the meat, were found to be full of tubercles. It was sold as wholesome, non-spoiled meat, after the removal of the "disgusting ulcers".

A decision of the Imperial Court of October 5, 1889, held that the positive factor in determining the spoiled condition consists in an alteration of the original or normal condition of the food or condiment to an inferior and consequently less fit condition for utilization for a certain purpose.

Finally, it should be remembered that only an actual violation of Sec. 10 is punishable. The attempt at violation is not punishable. Furthermore, the utilization of spoiled meat in one's own household and its donation to others is not subject to legal restrictions.

Section 12.

Imprisonment, together with the possible loss of civil rights, is provided for (1) all persons who purposely prepare articles which are intended to serve as food or condiment for others in such a manner that they may be injurious to human health, and all persons who knowingly sell, offer for sale, or otherwise traffic in as food or condiment, articles the consumption of which would be injurious to human health; (2) all persons who purposely prepare clothing materials, playthings, tapestry, eating, drinking, and cooking utensils, or petroleum in such a manner that the intended or future use of these articles is likely to be injurious to human health; and also all persons who knowingly sell, offer for sale, or otherwise have traffic in such articles.

Attempted evasions are punishable.

If on account of these forbidden actions a serious bodily injury or death of a human being is caused, the punishment is confinement in the workhouse for five years.

Section 13.

If in cases mentioned in Sec. 12 the consumption or use of the article was likely to injure human health, and if this fact was known to the vendor, the punishment is confinement in the workhouse for ten years; and if by the action in question the death of a human being is caused, confinement in the workhouse for not less than ten years or for life. In addition to the punishment, police supervision must be permitted.

The law of May 14, 1879, makes a fundamental difference between spoiled and dangerous or injurious food materials. Every case of the sale of injurious food materials, or even the attempt to

sell them, is punishable. If carelessness is not shown and at the same time harm is done to human health (Sec. 14), the punishment consists of imprisonment at least, but may involve confinement in the workhouse in the case of the death of a human being. The penalty for the violation of Sec. 12 can not be paid by a money fine.

In legal cases the wording of Sec. 12 must be observed, for, according to this section, it is not necessary for fulfilling the requirements of Sec. 12 that the food material should always produce an injurious effect. It is sufficient that the consumption of the food material should be, as a rule, calculated to injure human health (compare p. 110). On the other hand, according to a decision of Criminal Senate No. 2 of the Imperial Court, May 5, 1882, "the dangerousness is an objective quality which must attach to the article." Furthermore, the dangerousness must be present at the moment of sale or offering for sale. The bare possibility that meat may rapidly pass into decomposition and may thereby become dangerous is not sufficient (Decision II, of May 5, 1882). Likewise, the actual conditions of Sec. 12 do not exist in cases where the dangerousness of the food material was removed at the time of sale by the method of preparation, as, for example, by cooking (Decision I, of January 8, 1883). Neither is a person punishable for selling dangerous meat, not as a food material, but for some other purpose (Decision II, of March 11, 1881); nor is he punishable if, before selling the article which loses its dangerous character by cooking (for example, measly meat), he expressly declares that it can be eaten only in a cooked condition (Decisions IV, of August 11, 1884, and I, of January 15, 1885). The attempt to offer for sale is also punishable according to Sec. 12.

Decrees of the Imperial Court as a Commentary on Secs. 12 and 13.

A public sale, offering for sale, or bringing into traffic is not required; bringing into traffic signifies making the article accessible as food for another person. The sale of meat to middlemen, therefore, and the gratuitous disposal of the meat are also to be considered as bringing into traffic in the sense of Sec. 12 (Decisions I, of December 13, 1880, and III, of February 10, 1887); similarly, for the utilization of the material in one's private household, or giving it to wife, children, servants, associates, etc. (Decision II., of October 27, 1882).

Intentional bringing into traffic of injurious food materials presupposes: (1) that the dangerous character of the material is known to the vendor, and (2) that he understands that the person

to whom the injurious article is given will eat it himself or give it to others as a food material (Decision IV, of March 21, 1888).

An attempt to offer for sale was found in a case in which a butcher obtained injurious meat with full knowledge of its quality, brought it to his store, and there had it rinsed with water in order to remove the disagreeable odor (Decision III, of February 15, 1882). An attempt at sale was also found in another case, in consequence of preparing the meat for sale (cutting it into small pieces) (Decision I, of November 1, 1881), in sending the cut meat to another butcher shop (Decision II, of May 2, 1884); in transporting meat which was cut up and given gratis by a country butcher to a city inspection office (Decision of May 26, 1898); and, finally, in a case in which a beginning had been made in the use of the meat in material which had already been ordered (Decision II, of May 6, 1890). The mere possession of injurious wares is, on the other hand, no attempt to offer for sale (Decision III, of November 10, 1884). Laying the injurious meat out for the purpose of selling it is offering it for sale in the sense of Sec. 12 of the food law (Decision II., of December 23, 1887).

The attempt to sell presupposes that a beginning has been made in performing at least one of the actions which belong to the fact of an intended sale. The attempt to offer for sale exists if a beginning has been made in preparing the wares for sale to the public (Decision of June 5, 1890). An actual bringing into traffic can not be found in the transportation of food material, in and of itself, to a selling point (Decision of November 1, 1888).

Further Findings of the Imperial Court with Reference to Sections 12 and 13.

If a purchaser returns injurious food material to the vendor, the former may, according to Sec. 12, paragraph 1, of the food law, become guilty of a punishable bringing into traffic (Decision of September 27, 1887). Schmidt-Mülheim remarked in this connection that the consumer would do well, after he had become convinced of the injurious character of the meat he has bought, to destroy it or to call for the assistance of the sanitary police. The permission for the removal of a dangerous article for the purpose of utilization as food material (the case was one of trichinous meat which required boiling in a kettle) may also be considered as bringing into traffic in the sense of Sec. 12 of the food law (Decision of June 7, 1887).

Sec. 12 of the law of May 14, 1879, does not require that the consumption of the article in question (in this case it was measly

meat) shall in every case and under all conditions injure human health; or that for fulfilling the condition of fact an injury to health shall already have occurred. It is sufficient that the injury to health may occur under ordinary conditions and that, as a rule, it will occur (Decision IV, of September 29, 1885).

Injury to health takes place when by the action of a food material upon the body of the human being the organism suffers at least a partial disturbance of the ordinary vital functions. The health may also be injured by the aggravation of a disease (Decision III, of February 6, 1890).

The production of illness without an actual outbreak of disease is an injury to health in the sense of the food law. The imperial Court has handed down an opinion that not everything which is disgusting must necessarily be regarded as injurious to health. It was held, however, that it is legally unthinkable that a pathogenic influence upon the health could be found in a corporeal condition which in ordinary life is characterized as illness and which consists in an anomalous tendency toward the outbreak of disease. It follows therefrom that when a food material, according to its objective character is calculated to produce illness and disease in the person who eats it, it may also be considered as calculated to injure health (Decision IV, of December 8, 1893).

An injury to health is to be carefully distinguished from a disturbance of the health. According to Meyer and Finkelnburg, the technical criterion of an injury to health is to be found in the fact that it is transitory, without serious or permanent disturbance of the bodily or mental functions, while we may ascribe the property of disturbing health to an article when the consumption of it may lead to death or to such other consequences as are mentioned in Sec. 224 of the Criminal Law Statutes, which characterizes certain cases of bodily injury as "serious" when the injured person loses an important member of the body, sight in one or both eyes, hearing, speech, or reproductive power, or when these members or functions are permanently injured to a serious extent; or in cases where long illness, paralysis, or mental disease results.

Under the term lingering illness is understood any chronic disease which by attacking the organism produces a serious effect upon the general condition, even if the possibility of recovery exists (Decision II, of April 9, 1885).

The express declaration of the vendor that meat which loses its injurious character in cooking can be eaten only in a cooked condition protects him from punishment (Decision IV, of July 11, 1884).

The mere statement of the injurious character by the vendor to the purchaser does not entirely free the former from punishment, for the dangerousness of the transaction is not thereby removed (Decisions of January 15 and September 29, 1885). Disposing of food materials the injurious character of which may be removed by special treatment is non-punishable only in cases in which the vendor has made the necessary provisions for preventing its use in a dangerous condition (Decision IV, of March 21, 1888).

The subjective incrimination of the vendor according to Sec. 12 of the food law also disappears if he is convinced that the purchaser will remove the dangerous quality of the food material by suitable processes before it is eaten (Decision IV, of September 29, 1885).

Section 14.

If any one of the actions characterized in Secs. 12 or 13 are performed through carelessness, the punishment is a fine not exceeding 1,000 marks or imprisonment not exceeding six months; and if through the action in question an injury is caused to the health of a human being, the punishment is imprisonment for one year, or, if the death of a human being was caused, imprisonment for from one month to three years.

Meyer and Finkelnburg state that carelessness in the majority of instances is to be found in case the property of endangering or disturbing health was not known to the defendant and in case this was due to not giving it the attention which was required of him by the facts in the case. The degree of attention which must be given in this regard is considered purely a question of fact.

The Imperial Court (Decision III, of February 15, 1882) handed down the opinion that to establish carelessness it was immaterial whether a transaction was ordered by law or by regulation. The decision in question concerned the omission of trichina inspection in a locality in which trichina inspection had not been introduced by police ordinance.

It is the duty of the butcher to convince himself before selling the meat that it is not of a dangerous character (Decision IV, of June 1, 1886). The case was one of trafficking in measly meat. The Imperial Court rightly decided that the defendant had acted in a careless manner, inasmuch as he had neglected to exercise the necessary care and attention in the sale of the meat. It was held that if he had exercised care, even to the slightest extent, the injurious character of the meat could not have escaped his attention.

In conclusion, it should be remembered that living animals are also reckoned among food materials and condiments in the sense of Sec. 12 of the law of May 14, 1879, if the vendor knows that the

animals are to be used as human food (Decision III, of December 2, 1886, and Decision I, of October 6, 1892). This decision is applicable to cases of animals manifestly affected with an infectious disease (for example, tuberculous animals, hogs with tongue bladder-worms, etc.)

Decision III, of April 16, 1888, stated furthermore that the sale of a diseased animal with knowledge of the fact that it was to be killed immediately and eaten by human beings was punishable according to Secs. 10 and 11 of the law of May 14, 1879, if it was established that the meat of the animal at the time of sale and at the slaughter which followed immediately after, was spoiled in the sense of the law of May 14, 1879.

(c) Scientific Definition of the Term "Injurious to Health."

(Section 12 of the Food Law.)

From a legal standpoint, meat must be considered as injurious to health if it has been shown that it has already injured the health of consumers or if there is a scientific basis for the suspicion that such may be the result. Such meat, according to the text and intent of Sec. 12 of the food law, is "calculated to injure human health." In practice, however, the term "injurious to health" must be given a broader interpretation. According to the principles which determine the action of the sanitary police, in case of doubt it is necessary to make the more unfavorable assumption and to consider that meat is injurious to health if its harmless character is not established. Samples of meat known by experience to be injurious to health, are meat of animals suffering from septic and pyemic diseases (meat poisoning), meat containing trichina and cysticerci, meat of animals affected with anthrax and glanders, as well as decaying and otherwise decomposed meat (sausage and mince-meat poisoning). Samples of meat which, on the basis of scientific demonstration, must be regarded as injurious to health, are tuberculous organs and the meat of animals which are affected with certain forms of tuberculosis.

Concerning the connection between injury to health and the consumption of the meat of diseased animals, the materials worked over in the Imperial Health Office for the technical foundation of the draft of the food law contain the following considerations:

Conclusive proof that certain diseases in man are caused by the consumption of the meat of animals slaughtered while in a certain diseased condition is often very difficult to procure. On the

one hand, the diseases do not appear immediately after eating the meat. At times, in fact, they may appear only after the lapse of a considerable time after the persons concerned have eaten the meat of various other animals. Moreover, meat dealers, especially the so-called "cold butchers," understand, as a rule, how to arrange the slaughtering of diseased animals and the sale of the meat so that the causal connection between possible diseases in man and the slaughter of diseased animals performed by the butchers is obscured as much as possible. This purpose is well served by the method of secretly transporting the affected animals to a distant locality and slaughtering them there as quickly as possible, or by bringing the meat of diseased animals which were slaughtered in one place to another distant locality, commonly to a larger city. Not infrequently the diseased meat is first disposed of to middlemen, or it is sold with the meat of other animals slaughtered in a demonstrably healthy condition and under the pretence of coming from the latter. Frequently, diseased meat is utilized in the manufacture of sausages in order to prevent the discovery that it is pathologically altered. The frequency of this experience is apparent from the fact that meat dealers who slaughter diseased meat in a wholesale manner are in many regions called sausage butchers.

With regard to the method of determining the injurious character of food materials, we are subject to a serious limitation. Only in a few instances are we in a position by exact, unexceptionable experiments on man to answer the question whether the meat possesses harmful properties or not. Previously, experiments of this sort with measly meat and with the milk of aphthous animals have been made by self-sacrificing investigators (Perroncito and Hertwig), on themselves and partly on criminals condemned to death (Küchenmeister's experiments with measly pork). Quite heroic experiments were made by the General Veterinarian of the French army, Decroix, upon himself with the meat of animals which had been affected with various diseases and part of which had died in consequence. Decroix ventured to eat the meat even from cases of acute glanders, rabies, trichinosis, pyemia, and perforated peritonitis, and, fortunately, did not suffer any injury to his health.*

In the majority of cases we are limited to experiments upon animals and to ordinary experience. Experiments upon animals serve only to give a basis to the suspicion that the conditions are similar in man to those in the experimental animals, and this has

* Decroix, "Recherches Expérimentales sur la Viande de Cheval et sur les Viandes insalubres." Paris, 1885.

reference only to such diseases of domesticated animals as are generally known to occur in man (for example, tuberculosis, glanders and anthrax). The transmissibility of a disease of a domesticated animal to an experimental animal proves nothing in itself regarding the possibility of transmission to man, for there are many diseases of domesticated animals which are transmissible to experimental animals but which, according to experience, are not transmissible to man; as, for example, hemorrhagic septicemia, black leg, swine erysipelas, etc. In applying to man the results which are obtained with animals, the manner of transferring the virus must also be considered. Intraperitoneal or subcutaneous inoculation is no proof of injurious action in the case of introduction into the alimentary tract. In the latter case the harmful effect of the digestive juices upon the bacteria and also the unfavorable conditions for anaerobic bacteria in the stomach and alimentary tract enter into the problem. Anthrax bacilli, for example, in the majority of warm-blooded animals, produce anthrax after a subcutaneous injection, while after feeding, on the contrary, infection does not take place in a number of animals including man. With regard to tuberculous sputum, Bollinger demonstrated that it would produce an infection in case of subcutaneous or intraperitoneal injection when diluted to the extent of 1:100,000, while it lost its virulence in case of administration through the alimentary tract even in a dilution of 1:8. Nocard injected the muscle serum of 21 cows into guinea pigs. In these experiments it was shown that the muscle serum of a cow was virulent. The meat of the same cow, however, was eaten in considerable quantities (about 500 grams) by four cats without any injurious effects. Finally, Sormani demonstrated that a 10,000 times greater quantity of tetanus virus was endured in the alimentary canal than in the subcutaneous connective tissue.

With regard to the majority of the diseases of domesticated animals, we know by experience that they are not communicable to man. This fact of experience is both of a negative and of a positive character; negative in so far as it has been shown by clinical observation and numerous post mortem examinations of man that diseases which are common in domesticated animals do not occur in man; of a positive nature, on the other hand, in so far as the meat of diseased animals has been eaten in innumerable cases without harm. For example, this has been proved by hundreds and thousands of experiences with the meat of animals which were affected with rinderpest, pleuro-pneumonia, or swine erysipelas.

Feeding experiments with the meat of such animals have been on a very large scale in man, and it requires no further proof that, as against this tremendous mass of experience, one isolated contradictory observation has no weight, especially if the latter can not be considered entirely unexceptionable. I emphasize this point with regard to the isolated observations contained in the literature of the subject concerning the alleged injurious character of meat containing psorosperms, the meat of hogs affected with swine plague, of cattle suffering from rinderpest, and of chickens affected with fowl cholera, observations which thus far have not been substantiated by other authors and which are much more easily explained by the assumption of the development of a cadaveric injurious property.

(d) Differentiation of Meat and of Meat Products, According to the Regulations of the Food Law.

According to the law of May 14, 1879, we must distinguish in the practice of meat inspection, and *pro foro*, the following classes:

1. Good products, or those which are fit to eat and which may be freely admitted to the market.

2. Meat which is to be considered "spoiled in the sense of the food law." * This meat corresponds to the inferior meat of the meat inspection law ("meat which is really fit for consumption by man but which is considerably depreciated in its nutritive and condimental value"). Such meat can be offered for sale and sold only under declaration and upon the freibank.

The Imperial Prussian Administrative Court declared (Decision I, of February 20, 1900) that a police ordinance according to which "spoiled" or inferior meat was ordered upon the freibank was binding. It was held that the police had the right to take action against the criminal sale or offering for sale of "spoiled" or inferior meat and that the transfer of this meat to the freibank protected the producer against violation of the criminal law.

Other methods of bringing into traffic (use in one's own household and the giving gratis to others) are not subject to legal restrictions. In the older ordinances, spoiled meat was characterized as non-marketable.

3. Unconditionally dangerous or injurious meat, in the case of which any method of trafficking in as human food material, its use in one's own household, giving gratis to others, permission for its

* In the following discussion, for the sake of brevity, this will be referred to simply as spoiled.

removal, etc., is forbidden (see pages 108, 109). With this meat, which constitutes a part of the meat unfit for food in the sense of the meat inspection law, procedure should take place according to Sec. 9 of the meat inspection law.

4. Conditionally injurious meat which can be made fit for food by proper measures, such as cooking, roasting, steaming, pickling, or preservation in cold storage.

The conditionally injurious meat forms a part of the meat which is conditionally fit for food in the sense of the meat inspection law. The other part of the meat which is conditionally fit for food is that which for veterinary police reasons must be rendered utilizable before it is admitted to the market (compare page 83). Such meat after the required conditions have been fulfilled is to be treated as spoiled meat in the sense of the food law and to be admitted to market only after declaration (Sec. 11 of the meat inspection law).

5. Finally, we have to distinguish meat which is spoiled in a high degree and which, without being injurious to health, has lost the quality of human food material on account of extensive, substantial deterioration; for example, watery and ill-smelling meat, meat and organs which are extensively infested with harmless or dead parasites, etc.). This meat is unfit for food in the sense of the meat inspection law and is subject to the regulations of Sec. 9 of the meat inspection law in the same manner as that mentioned above under paragraph 3.

Among meat products we distinguish, moreover, imitations and adulterations.

It should be remembered that the expert meat inspector should use the word "spoiled" only in the sense of the law and not as indicating meat in process of decomposition; for decomposing meat is an injurious food material.

The meaning of "unclean" meat. Attention has already been called (page 40) to the fact that in one part of the Kingdom of Prussia privileged knackers, according to the decree of April 29, 1772, received the rejected animals which were found unclean at the time of slaughter, in their immediate neighborhood (sheep excepted). The concept "rejected" was explained by a ministerial decree of May 11, 1887, to the Kurmark Chamber of War and Public Domains with the statement that by this term was to be understood "all animals which are unfit for further use by man". An official interpretation of the meaning of "unclean" does not exist. The term in question is a relic of the oldest German

ordinances concerning meat inspection, in which it was incorporated through the medium of the Christian Church from the food laws of the Jews and Egyptians. Dieckerhoff suggests, as an explanation of this historical term, that it is to be understood as including injurious meat, an explanation which agrees closely with legal decisions. Thus, the Official Court at Eberwalde, in an opinion handed down August 11, 1890, declared that for the determination of the concept "unclean" the same characterization must be considered decisive as is mentioned in the ministerial decree of May 11, 1787, with regard to the term rejected. It was held that animals are to be considered as unclean if the meat can not be eaten, on account of its diseased condition, or if it should not be eaten, on account of being dangerous to health.

In this sense the term unclean may be applied also to tuberculosis of cattle, in spite of the fact that by the decree of July 26, 1785, it was declared with reference to the "French disease," that butchers would no longer, under any circumstances, be permitted to declare slaughtered animals as unclean and infected with this disease, for this decree is not a general regulation, but an instruction based upon the opinion of the chief sanitary officer, and one which, therefore, may lose its foundation by the alteration of the views of the sanitary veterinarians on this point (decision of the Government Court at Stolp, February 22, 1892).

3.—Imperial Law Concerning the Prevention and Suppression of Animal Plagues of June 23, 1880, and May 1, 1894.

According to Sec. 17 of this law, public abattoirs are subject to the inspection of official veterinarians, and the same measures may be adopted with reference to private slaughterhouses. Section 17 reads, "all stock and horse markets, as well as all public abattoirs, shall be inspected by official veterinarians. These regulations may also be extended so as to apply to herds of stock brought together in public or private quarters for the purpose of public sale, male animals used for breeding purposes in a public manner, public stock shows and collections of horses and herds of stock brought together by regulation of the authorities, as well as feeding stalls, private slaughterhouses, and the stalls of stock dealers. The veterinarian is required to make known immediately to the police authority all cases of infectious plagues or all symptoms which arouse suspicion of disease which are observed in the market or among the above mentioned herds of horses and cattle. He shall

make an immediate investigation of the case and enforce the required police protective regulations. If there is danger of the spreading of the disease, the veterinarian is authorized, before police interference, to order the isolation and observation of the diseased and suspected animals."

For the execution of Sec. 17 of the Imperial law concerning animal plagues, the following orders of the Imperial Government President at Merseburg are worthy of notice as model regulations:

I.—Police Regulation Concerning the Supervision of Private Slaughter Houses, etc., February 29, 1896.

On the basis of Sec. 17 of the Imperial law concerning animal plagues, according to an interpretation of May 1, 1894, and also on the basis of Sec. 7 of the Prussian enacting clause of March 12, 1881, I prescribe the following regulations for the territory of the government district of Merseburg:

Sec. 1. Herds of animals brought together by dealers in public or private places for the purpose of public sale, public animal shows, private slaughterhouses, together with the apartments which belong to them, as well as the stalls of cattle dealers, whether used for private purposes or rented, are to be inspected by the local official veterinarians.

Sec. 2. The term "herds of animals," in the sense of this regulation, is to be understood as including horses, cattle, sheep and hogs, irrespective of number or age.

Sec. 3. Access to the places characterized in Sec. 1 is to be at all times permitted to official veterinarians for the purpose of making inspections.

Sec. 4. The costs of this supervision, according to Sec. 7 of the Prussian decree of enforcement of June 18, 1894, and Sec. 24 of the above mentioned enacting clause, must be borne by the dealers, and in case an agreement can not be reached concerning them, they will be fixed by me. If the costs are not paid punctually, legal prosecution will be begun.

Sec. 5. This regulation becomes operative on the day of its promulgation. From this day the governmental police regulation of August 15, 1895, concerning the inspection of slaughterhouses, etc., is repealed.

II.—State Police Regulation Concerning the Supervision of Public Slaughterhouses, February 29, 1896.

In connection with the state police regulation decreed by me to-day and promulgated in the Official Circular concerning the inspection of herds of animals brought together for the purpose of public sale, public animal shows, etc., by official veterinarians, as well as for the purpose of amendment and extension of my circular letter of August 15, of the previous year, I hereby decree as follows:

1. The veterinary police supervision of public slaughterhouses prescribed in Sec. 17 of the Imperial law concerning animal plagues in the interpretation of May 1, 1894, shall be carried out in Halle by the department veterinarian at least once per month, and in other localities of this district by the local district veterinarians with the frequency which has already been ordered in the above mentioned circular letter. Inspection shall be unannounced and thorough.

2. The district veterinarians shall perform this veterinary police inspection in such a manner that they direct their attention entirely to the field of action which concerns the veterinary police. Thus they shall have regard to all regulations decreed

concerning the prevention and suppression of animal diseases and shall also give attention to the detection of animal plagues and the prevention of the dissemination of such plagues.

The department veterinarian, on the other hand, shall direct his supervisory activity to the organization and the management of the slaughterhouses as a whole, to the technical work of the slaughterhouse experts, especially to the manner of the inspection of animals before slaughter, the procedure in slaughter, the management of meat inspection, including trichina inspection, keeping the books containing records of inspection, the cleansing of slaughtering rooms and other communicating rooms, cold storage, lard rendering stalls, platforms for animals, utensils, etc., as well as to the disposition of meat unfit for human food, the treatment and sale of inferior meat, and the treatment and removal of manure, etc.

3. In the same manner the department veterinarian shall make a thorough inspection, at least once during each calendar year, of the other public slaughterhouses within his district. This may be done incidentally upon his official trips.

4. In case improper conduct or violations of existing regulations are discovered during these inspection tours, the director of the slaughterhouse shall have his attention immediately called to the same and an announcement shall be made to the police officials or to the proper magistrate. If such abuses are not quickly corrected, or if the discoveries and observations are of special importance, a report shall be rendered to me without delay.

5. The directors of slaughterhouses are instructed to further the execution of this supervision so far as they are able and upon request to furnish all possible information concerning the organization, management, etc., of the slaughterhouses subject to their inspection.

6. The costs of the veterinary police supervision, according to Sec. 7 of the Prussian decree of enforcement of June 18, 1894, and Sec. 24 of the Prussian decree of enforcement of March 12, 1881, with reference to the above mentioned Imperial law concerning animal plagues, shall be borne by the dealers, and, in case no agreement is reached, shall be determined by me. On the other hand, the expenses of other inspections are to be borne by the State Treasurer. In calculating the fees for the prescribed services, the provisions of the law of March 9, 1872, concerning the fees of medical officials, shall be authoritative.

IMPERIAL GOVERNMENT PRESIDENT,

Merseburg, February 29, 1896. Graf zu Stolberg.

In addition to compulsory notification for all plagues mentioned in the Imperial law concerning animal plagues of May 1, 1894 (especially anthrax, rabies, glanders, foot-and-mouth disease, pleuro-pneumonia, sheep pox, mange of horses and sheep), the following provisions concerning the procedure with meat of animals suffering from an infectious disease should be considered :*

* On the basis of Sec. 10, sentence 2, of the Imperial law concerning animal plagues, swine erysipelas, swine plague, and hog cholera, as well as fowl cholera, are subject to compulsory notification. Moreover, in the Prussian Province of Saxony and in the Kingdom of Saxony, this requirement extends to the so-called Borna horse disease, and in the Province of East Prussia to horse distemper and pneumonia of horses.

Sec. 31. "No animals which are affected or suspected of being affected with anthrax shall be slaughtered." Sec. 33. "The carcasses of dead or slaughtered animals affected or suspected of being affected with anthrax must be immediately destroyed. The removal of the hide of such animals is forbidden."

Sec. 36. "The slaughter of rabid animals or those suspected of rabies, and all sale or use of individual parts, milk, or other products of the same are forbidden."

Sec. 39. "The carcasses of slaughtered rabid animals or animals suspected of rabies must be immediately destroyed. The removal of the hide is forbidden."

Sec. 43. "The carcasses of dead or slaughtered glanderous animals must be immediately destroyed. The removal of the hide of the same is forbidden."

Secs. 53 to 56 contain special provisions concerning the procedure in the reduction of plagues in stock yards and public slaughterhouses:

Sec. 53. "The aforementioned regulations of this law, with such alterations as appear in the following special provisions, are applicable to stock yards and public abattoirs which are subject to a regular veterinary police control, and to the food animals which are brought to such places."

Sec. 54. "If, among the food animals brought to such places, the outbreak of an infectious disease is discovered, or if symptoms appear which, according to the opinion of the official veterinarian, justify the fear of an outbreak of such a plague, the diseased and all suspected animals are to be immediately taken under police supervision and prevented from coming into contact with other animals."

Sec. 55. "So far as the nature of the disease permits (compare Secs. 31, 36 and 43), the owner, or the representative of the owner, of the diseased or suspected food animal may be required to slaughter the animal immediately under the supervision of the official veterinarian and in the rooms intended for that purpose."

"This regulation may in urgent cases be extended to include all other animals which are susceptible to the disease and which are in the place in question."

Sec. 56. "After the discovery of an outbreak of a plague, and as long as there is danger from the plague, the stock yards or public slaughterhouses may be closed to prevent the removal of animals which are susceptible to the plague. More stringent quarantine measures may be applied only in urgent cases."

From the instruction of the Federal Council of June 27, 1895, with reference to the execution of Secs. 19 to 29 of the Imperial law concerning animal plagues, the following paragraphs are of importance for meat inspection:

General.—Sec. 2. "To stock yards, public slaughterhouses, and food animals brought to such places, subject to a regulated veterinary police control, the provisions of these instructions are applicable only in so far as they are in harmony with the regulations of Secs. 53 to 56 of the law (see above). In particular, the provisions of these instructions concerning public notification of an outbreak of a plague and concerning restrictions in traffic with reference to the animals and persons which come in contact with them are not applicable to the institutions mentioned above."

Foot-and-mouth disease.—Sec. 62. "Hides of dead or slaughtered diseased animals may be removed from quarantine only in a completely dried condition, except in case they are delivered directly to the tannery."

Pleuro-pneumonia.—Sec. 89. "Lungs of animals slaughtered on account of pleuro-pneumonia or dead of this disease must be buried at least one meter deep in order to render them harmless. The meat of such animals shall not be removed from the premises in question until it has been thoroughly frozen. The skins of animals dead of pleuro-pneumonia shall not be removed from the premises in question or from the slaughterhouse unless in a completely dried condition, except in case they are delivered immediately to the tanner."

Sheep pox.—Sec. 97^{10}. "Skins of dead or slaughtered sheep affected with sheep pox shall be removed from quarantine only in a completely dried condition, except in case they are delivered directly to the tanner."

Mange.—In case of mange in horses and sheep the skins are subject to the same restrictions in traffic as in the case of foot-and-mouth disease and sheep pox."

4.—Imperial Law Concerning Measures Against Rinderpest, April 7, 1869.

This law, which originally was operative only for the region of the North German Federation, but which in 1870 and 1871 was also introduced into Baden, Hessen, Bavaria, Würtemburg and Alsace-Lorraine, prescribes incineration of animals slaughtered on account of infection from rinderpest or dead of this disease.

III.

THE ART OF BUTCHERING, INCLUDING THE INSPECTION OF ANIMALS BEFORE SLAUGHTERING.

1.—Food Animals.

To the food animals belong, in the first place, cattle, sheep, and hogs, then goats and horses; moreover, in southern and southeastern European countries, the buffalo is slaughtered, and, in a portion of the Scandinavian countries, the reindeer.* Lately dogs have also been slaughtered for use as human food (Italy and Saxony).

Of the domestic food animals just mentioned, the hog, at least so far as Germany is concerned, furnishes the greatest amount of meat for human food. With us pork is the most important food material of the people, and this is the case for the reason that it may be prepared without the addition of any other fat, and can be preserved, by pickling and smoking, to a greater extent than any other kind of meat, without losing its food value. The annual consumption of meat in the year 1896–7 in Madgeburg amounted to 60.52 kg. per capita. This amount was distributed as follows: 29 kg. of pork, 25 kg. of beef, 3.8 kg. of veal, 2.5 kg. of mutton, and 1.4 kg. of horse meat.

In Königsberg, in Prussia, the excess of pork in the year 1895–6 was still greater. Of the 40.66 kg. of meat consumed per capita during that year, 23.32 kg. was pork, 11.65 beef, 2.85 veal, 2.20 mutton, and 0.65 horse meat.

Similar conditions prevail throughout the German Empire (compare page 4). In southern Germany, beef in former years occupied the first place as an animal food material. During the last ten years, however, the consumption of pork has increased considerably, while the amount of beef eaten has simultaneously decreased. As a mere curiosity, it may be mentioned that in

* In Irlemarken, in eastern Norway, a company is engaged in breeding reindeer for slaughter. The company expects to be able to slaughter 1,000 reindeer a year, the meat of which is to be exported.

southern France, Italy, and Spain regulations exist, according to which the slaughtering of hogs is forbidden during the summer months. The reason for this prohibition is found in the wide-spread assumption among the common people that pork is unwholesome during the hot season. Apparently we have here a case of a blindly-accepted tradition, the beginning of which is to be referred to the prohibition of the use of pork in Oriental food laws.

Hippophagy.—The broken bones of horses in all the historical caves of Europe leave no doubt, according to William Boyd Dawkins, that horse meat was in use as a food material in ancient times. The Christian Church issued a prohibitive decree against it for the reason that horse meat was sacrificed and eaten by the Germans in honor of Odin and Freya. The present prejudice against the consumption of horse meat is a remarkable example of the change of taste brought about by a church order against a belief which has been forgotten. Among the nomadic people, for example, the Tartars, Kirghis, and Kalmucks, hippophagy has continued to the present day without interruption. Likewise in China the consumption of horse meat is an old custom. For many centuries in that country a special "fat horse" has been bred for this particular purpose, a breed which is characterized by delicate bone structure, savory meat, and great fattening powers.

The first of the civilized peoples to return to the consumption of horse meat were the Danes. The Danish government, during the siege of Copenhagen, in 1807, permitted the sale of horse meat, and from Denmark hippophagy gradually spread to its present extent. In Germany during the years of high prices, 1816–17, much horse meat was eaten. Horses, however, were for the most part slaughtered surreptitiously. It was the hard times of 1847 that induced Prof. Spinola, then connected with the Berlin Veterinary School, and Blume, the Court opera singer, to establish a slaughterhouse for horses in Berlin. As a result, after a year's time, eleven such establishments had been erected in Berlin, in which a total number of 3,000 horses were slaughtered. Morot presents figures to show that the consumption of horse meat during the last thirty years has considerably increased in nearly all countries. In France there exists a "Comité de la viande de Cheval," which deserves great credit for the extension of the consumption of horse meat. The first slaughterhouse for horses was opened in Paris under the management of the army veterinarian, Decroix, July 9, 1866. During the following half-year 902 horses were slaughtered. The number

of horses slaughtered increased, however, in 1869 to 2,758; in 1872 to 5,732; and reached, in 1887, the large number of 16,446. During the siege and regime of the Commune in Paris, not less than 65,000 horses were eaten. Morot emphatically recommends a further extension of hippophagy and lays stress upon the fact that thereby an immense sum which at present is partly expended for American beef would remain in the country. In 1894, 23,186 horses, 383 asses, and 33 mules were slaughtered, which together yielded 5,129,530 kg. of meat. More than 100,000 of the 600,000 to 700,000 families in Paris eat horse meat, "la bidoche" (from *bidet*, a mare), as it is technically called. Moreover, horse meat in Paris, as with us, has more secret buyers than open admirers. At any rate, Villain says that two-thirds of all the solipeds slaughtered are utilized in the manufacture of sausage.

The number of horses which were slaughtered in public abattoirs and in the several horse abattoirs of Prussia in the year 1899 amounted to 63,801. The number of horse abattoirs was 365 and the great number of horses, 10,037, were slaughtered in Berlin. More than 5,000 were slaughtered in the governmental districts, Breslau and Düsseldorf; more than 3,000 in the governmental districts, Liegnitz, Magdeburg, Merseburg, Schleswig, and Arnsberg, or in the more thickly populated districts; while in the less thickly populated eastern provinces only a few horses were utilized as food by the people. A strikingly small number of horses were slaughtered in the governmental districts of Posen and Bromberg.* In 1890–91, the number of horses slaughtered in Prussia was 53,281; in 1893–4, 58,306. In the Kingdom of Saxony in 1885, 3,313 horses were slaughtered; in 1890, 4,249; in 1896, 5,091; and in 1899, 5,187. In Leipsic the number of horses slaughtered in 1895 was 961 and in 1900, 1,839. In Dresden during the year 1899, 1,478 horses were slaughtered; in Munich the consumption of horses was doubled during the 80's. Nevertheless, the number of horses slaughtered in 1890 was only 1,728. In Vienna, during 1892, 18.209 horses were slaughtered.

During the exclusive consumption of horse meat, as shown by the recent experience of beleaguered cities in China and the Transvaal, cases of diarrhea may appear. This was observed also in consequence of eating dogs. According to Pflüger, a substance soluble in alcohol is contained in horse meat and passes over into the meat broth. This substance may produce diarrhea. It consists

*This is due to the unconquerable antipathy of the Polish population against the consumption of horse meat.

of three-fourths lecithin and one-fourth neutral fat and cholesterin. The injurious effect of horse meat is not produced if it is prepared with beef or mutton tallow or if the meat broth is poured off.

The slaughter of dogs appears, according to an official document of a magistrate in Munich, to have become so extensive that the authorities wish to establish measures which will regulate the traffic in dog meat and protect the owners of dogs from the thieving tendencies of commercial dog butchers. A portion of the dogs which were slaughtered were shown to have been stolen. It is believed that dog meat is not only used for the adulteration of sausage, but is also eaten as a delicacy by the thousands of Italian workmen in Munich.

Dogs are regularly slaughtered in certain abattoirs in Saxony. Thus, in 1889, 233 dogs were slaughtered in Chemnitz, 102 in Leipsic and Zittau; while in 1890, 312 were slaughtered in Chemnitz and 103 in Leipsic. In the latter city the number of dogs has considerably increased and in 1900 amounted to only 15. In the whole Kingdom of Saxony in 1899 there were 468 dogs slaughtered.

According to Villain, the dog is a highly esteemed food animal among the Chinese as well as among the Tartars and the inhabitants of Kamchatka. In Senegal also and in the Society Islands, dog meat is readily consumed and is even preferred to pork. For a long time experiments have been made in Germany to introduce the consumption of rabbit meat, which in England, France and Italy furnishes a favorite article of food. These efforts, however, have been without result. According to Boutel, the daily consumption of rabbits in Paris amounts to 10,000 and in London to 75,000. In France as a whole, 100,000,000 rabbits are raised annually and have a value of 300,000,000 francs. The rabbit is the most productive of the domestic animals. For example, one female weighing 4½ kg. may, in the course of a year, produce 50 young, which at the age of four months furnish 150 kg. of meat.

In addition to the mammals already mentioned, fowls also belong to domestic food animals. There is no system of meat inspection for fowls or for rabbits slaughtered for home consumption. In the case of fowls and rabbits there is simply a supervision of the offering for sale and sale, a control of the market, like that exercised in the case of game, fish, crustaceans and mollusks intended for human food. (Compare Drechsler, "Selection, Purchase and Judgment of our Animal Food, Together with Food Materials of Animal Origin." Munich, 1897.)

The last named animals, rabbits, fowls, game, fish, crustacea and mollusks, will be considered only so far as they show an anomalous condition. Moreover, in judging of the meat of domestic fowl and game, the same principles should apply as for the more important domestic food animals, cattle, sheep, hogs and horses. With regard to goats, the same statement, in general, may be made as for sheep.

2.—Inspection of Animals Before Slaughter.

Purpose.—The inspection of animals before slaughter may be omitted only in cases in which there is danger of natural death by postponing the slaughter (in urgent cases of emergency slaughter).* In all other cases inspection must be made, and for the following reasons:

1. For the purpose of the immediate detection and isolation of animals suffering from an infectious disease.†

2. In order to prevent the infection of the employees of slaughterhouses with diseases which are communicable to man; for example, glanders, anthrax and rabies.

3. For the purpose of the certain detection of intoxications and septic diseases, in which the internal organs and meat may show only slight alterations.

Finally, in localities where a system of insurance of food animals exists, the inspection of animals before slaughter is made in the interest of this insurance, since thereby animals which are evidently or presumably diseased are excluded from insurance.

Practice.—In this place we may omit a description of the pathological symptoms to which attention should be given in the inspection of living food animals, for the reason that these must be perfectly familiar to every veterinary expert. Only the following points need be emphasized:

The transportation of animals may produce symptoms which could be interpreted as the expression of a disease. In this connection we should mention especially the exhaustion of animals which in consequence of continual confinement in stalls are unused

* In such cases, however, the meat can not be admitted for utilization as a human food material unless the conditions found upon slaughter leave no doubt as to its harmlessness. (See under "Emergency Slaughter.")

† For this purpose a so-called police or sanitary slaughterhouse must be established in connection with every abattoir.

to all exercise (bulls, milch cows, fat hogs). Refusal of food and dulness of the sensorium may occur; these symptoms, however, usually disappear after several hours' rest. Furthermore, we may observe, in consequence of long transportation, lameness as a result of injuries to the hoof (confusion with foot-and-mouth disease), bruises and injuries of the skin, especially in cattle and sheep, and consequent hemorrhages and accumulations of air under the skin (confusion with anthrax and black leg).

Transportation and period of rest before slaughter.—It is the general practice not to permit the immediate slaughter of animals which are exhausted by a long journey, but only after a period of rest. The meat inspection regulation in Dessau provides, for example, that food animals shall be allowed a resting period before slaughter, eight hours in winter after being driven on the hoof, and four hours after transportation by rail; in summer, on the other hand, twelve and six hours respectively.

This provision is in accordance with the fact that exhausted animals bleed imperfectly, and the meat consequently shows a poorer keeping quality than that of rested animals. The meat naturally begins to decompose more rapidly, but, if properly treated immediately after slaughter, undergoes a chemical decomposition which among butchers goes by the name "smothering."

Provisions concerning the transportation of food animals by rail.—In consequence of the improper loading of food animals in cars, quite frequently serious injuries and even death may be occasioned. Fat hogs during the summer are most subject to these accidents. As is the case in forced driving on the hoof, they may die of suffocation in railroad cars if they are loaded too closely in poorly ventilated cars. Even cattle may die in crowded cars if the latter are so overloaded that animals which fall down during transportation are unable to get up. Cattle frequently die during transportation from suffocation or in consequence of trampling by animals which stand next to them. The Agricultural Union at Braunsberg, for the purpose of preventing such accidents during transportation by rail, made a request for the introduction of ventilating devices in the roofs of cars and in the doors so that a space for one beef animal or one medium sized horse of 1.5 square meters, or for three calves or two hogs of 100 kg. weight, or for nine young pigs, or three sheep, one square meter of floor surface be provided. In Russia, special animal transportation cars are used, which are

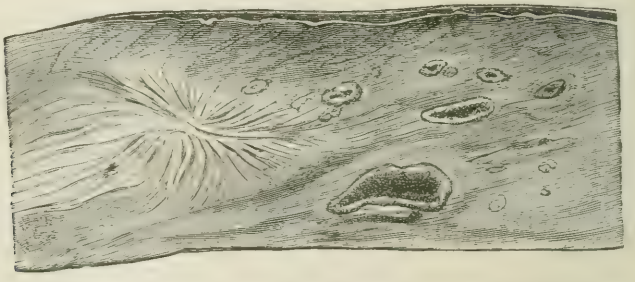
provided with arrangements for ventilation, suitable heating, feed racks, pipes for introducing water, trap doors for the removal of the feces, and suitable quarters for the attendants.

"Railroad disease" of cattle.—Röder frequently observed cattle which were affected with a peculiar condition characterized by cattle dealers as "railroad disease". After being unloaded the animals exhibited a wavering gait and passed into a condition which resembled parturient paresis. The pulse was accelerated to 100 without an elevation of temperature. Respiration was spasmodic; appetite and rumination were suspended and the attack terminated unfavorably.

Horses must in every individual case be examined for glanders (nasal cavity, larynx, general integument, etc.). In other domesticated animals the inspection in general may be a cursory one and may be confined to an observation of the general appearance and the more important vegetative and sensory functions. The best time for inspecting animals is during feeding. Animals which are lying down should be made to get up. Lame animals are to be driven back and forth, and animals which are evidently exhausted should be again examined after a period of rest. Animals which are suspected of being diseased must be subject to inspection *lege artis.*

The most important diseases.—The chief interest in the inspection before slaughter attaches to the typical infectious diseases, the

FIG. 1.



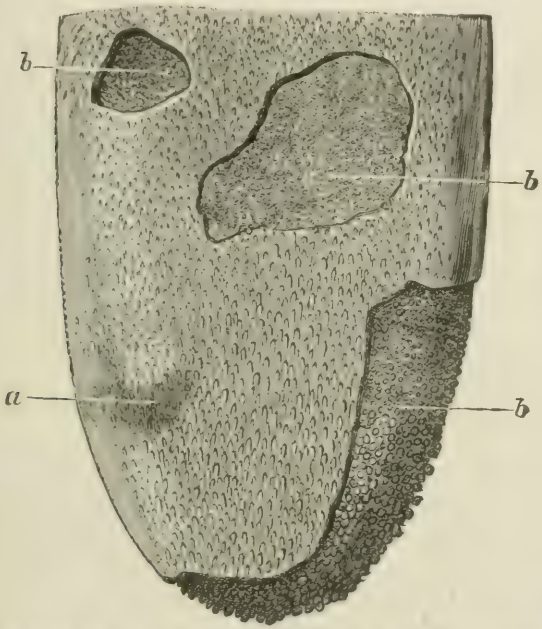
Nasal septum of horse with glanderous ulcers and a cicatrix.

intoxications and septic diseases of food animals. The infectious diseases most frequently observed in stock-yards are glanders in the horse, foot-and-mouth disease in cattle and hogs, anthrax in cattle and sheep, swine erysipelas and urticaria in hogs. The latter disease is the only one in which treatment is indicated (laxatives), and slaughter should be postponed until recovery takes place, since the

disease, as a rule, runs a favorable course, but the meat after recovery shows only unimportant alterations, as compared with those which are present at the crisis of the disease.

By far the most frequent disease in stock-yards and abattoirs is aphtha. With reference to this disease, since it frequently happens, especially in the case of hogs, that veterinarians first become well acquainted with it in abattoirs, it should be remembered that in hogs, as a rule, the hoofs are affected and rarely the mouth, and that the first form of the disease is made apparent, when the

Fig. 2.



Aphtha. Tip of beef tongue: *a*, aphtha; *b*, epithelial erosion after bursting of the aphtha.

animals are driven out of the stalls, by lameness and by the aphthous patches or slightly bleeding surfaces on the hoofs.

Among septic diseases, especial attention should be given to the so-called lameness and dysenterial looseness of the bowels in calves, to sepsis in connection with retention of the after-birth and septic mastitis in cows, to septic enteritis in cattle in general, and, finally, to septic diseases as a result of wounds in all animals.

Furthermore, it is desirable in inspecting animals which are intended for slaughter to give close attention to alterations of the

skin (parasitic eruptions, especially scabies in horses and sheep, actinomycotic tumors in horses and cattle), to discharges from the nose, rustling sounds in inspiration, disturbances of the brain functions, dulness of the sensorium, involuntary movements, and to motor disturbances (lameness and paralysis). In this way the expert simplifies, to a considerable extent, inspection after slaughter. It is then not necessary to make an inspection of the skin of the slaughtered animals, which, with the exception of hogs, is more difficult in all food animals after death than during life. It is also unnecessary to make a special inspection of the nasal cavities, brain and motor apparatus in cases of complete integrity of the upper respiratory passages and the absence of cerebral motor disturbances. The expert inspector saves himself the anatomical investigation of the hoofs, bones, and joints, by an inspection of animals before slaughter. These parts are to be subjected to a more detailed examination after slaughter in cases in which pathological processes during life caused a suspicion of alterations in them.

Before we proceed to discuss the inspection of the internal organs and the meat of slaughtered animals, it appears desirable to give a brief account of the most important methods of slaughter and the order of procedure in practical slaughtering.

3.—Methods of Slaughter.

In slaughtering, death must be brought about quickly and with the avoidance of unnecessary pain.* The methods of slaughter in common use with us serve also the purpose of securing the greatest possible keeping quality for the meat. This purpose is fulfilled by opening the large cervical vessels or anterior thoracic vessels of the animals and removing as much blood as possible. Blood passes very quickly into decomposition. Only one method, the so-called English patent method, is operated without bleeding. By this method the animals are suffocated (compression of the lungs by forcing in air by means of a bellows and a sharp canula inserted into the pleural cavity).

Meat obtained by this method possesses a higher food value in consequence of its containing all of the blood, but for the same reason has a diminished keeping property and does not exhibit the

*Sec. 360[13] of the Criminal Law Statute of the German Empire provides a fine of 150 marks or imprisonment for any person who publicly or in anger causes severe pain to animals, or grossly maltreats them.

beautiful bright-red appetizing appearance of the meat of completely bled animals.

Quantity of blood and bleeding.—The total quantity of blood of animals amounts on an average to one-thirteenth of the body weight. This quantity, however, is not completely removed even by those methods of slaughter in which bleeding is most thorough. For all of the blood is removed only when the animals are not merely allowed to bleed, but when the individual parts of the body are deprived of the residual quantity of blood present in them, by the use of alkalies. The residual blood remains in the organs and in the flesh after ordinary commercial slaughter. This quantity, however, is so small that it is difficult on section through the organs or the musculature to obtain blood, even in drops, by pressure on the cut surfaces. Only occasionally it is possible to press out blood from the smaller veins. In cases of incomplete bleeding, such as occurs after previously mutilating the medulla oblongata, this is more easily accomplished.

With reference to the quantity of blood obtained in slaughtering, Heissler found quite considerable variations. Age was without any special influence. Male animals, on the other hand, yielded somewhat more blood than females. Furthermore, a fat condition, especially in hogs, was associated with a striking diminution in the quantity of blood. In horses the blood amounted to from 3.93 to 9 per cent. of the body weight; in cows, from 4.2 to 5.75 per cent.; in calves, from 4.4 to 6.67 per cent.; in sheep, from 4.37 to 5.56 per cent.; and in hogs, from 1.45 per cent., in the case of Hungarian hogs, to 5.75 per cent. in a yearling boar. In the abattoir at Bremen, the average weights of blood were found as follows: In the horse, 25 kg.; in cattle, 17.5; in colts, 7; in hogs, 3.5; in calves, 4.5; in sheep, 3; and in goats, 3 kg.

The average dressed weight of slaughtered animals was 238.6 kg. in horses, 254 in cattle, 100 in colts, 60 in calves, 77 in hogs, 21 in sheep, and 12.5 in goats.

All animals, with the exception of those which are slaughtered according to Jewish rites, are rendered unconscious before the blood is drawn. The number of animals slaughtered according to Jewish custom is, however, very small.

In contrast to the meat of animals which have been bled, that of animals which have died is characterized by the high blood content which appears in the darker coloration of all parts, espe-

cially, however, by the distended veins of the internal organs (particularly the liver) and of the subcutis.

By the term "cold butchering" is understood the subsequent sticking of dead animals. This manipulation, in which, in favorable cases, the non-coagulated contents of the severed vascular trunks are removed, is merely a deceptive operation, calculated to make a dead animal appear as if slaughtered in the ordinary manner.

Incomplete bleeding occurs during agony in case of diseased animals, if, in consequence of the weakened cardiac power, the blood pressure is already greatly lowered. The organs and meat of such animals are more or less rich in blood, according to the degree of bleeding. The greatest content of blood is usually found in the liver and subcutis. In animals exhausted by transportation bleeding is also incomplete.

The most important methods of slaughter.—The methods of slaughter in common use with us may be classified into three groups:

1. Simple bleeding by sticking in the thorax or cutting the throat. To this group belongs the Jewish method of slaughter.

2. Bleeding after previous mutilation of the medulla oblongata by pithing or by a blow.

3. Bleeding after previous stunning by means of a blow with a club, the so-called killing ax, killing mask, and shooting mask.

The procedures mentioned under 2 and 3 are frequently combined in stunning with a killing ax.

Practice of the Different Methods of Slaughter.

1.—Simple Bleeding by Sticking in the Chest or Cutting the Throat.

Thoracic bleeding is performed in such a manner that, without any preliminary operation, the larger vascular trunks (carotids and jugulars) at the entrance of the thorax are opened or severed by means of a sharp-pointed knife. Thoracic bleeding finds application with calves, sheep, and the larger domesticated animals in which, in consequence of certain diseases, an incipient paralysis of the brain is present (for example, parturient paresis).

Cervical bleeding, or *schächten*, is the common method of killing food animals among the Jews and Mohammedans. For practicing this method, the animals must be secured and thrown. This may be accomplished by the ordinary methods of throwing or by means

of windlasses fastened to the walls and ceiling of the room. The head is placed so that it lies upon the horns and nose. Hereupon, in ritual *schachten*, the neck is cut through to the spinal column by three rapidly-executed strokes with a long, exceedingly-sharp, nickless knife.

Israelites consider themselves bound by their religious laws to slaughter in this manner, or to abstain from the use of meat. A governmental prohibition of slaughter by the Jewish method would be an attack on the rights of the free practice of religion granted by tolerant governments.*

A blow on the head is declared by the Israelites as not permissible, for the reason that "perforation of the membranes of the brain" belongs to the eight mutilations which, according to the Mischna of the Talmud, render the meat *terephat* (unfit for food). Meat which is fit to eat is called *koscher* (in order, proper). "Let it be blest through me, O God, King of the world, who strengtheneth us in holiness by Thy commands and who hast made schächten a duty," murmurs the *schächter* (schochet), while he straps his knife before the operation or runs the hands over it to test it. If during the operation of cutting the throat the knife receives any nick, however small, the "schechita" is not correctly performed. The animal is condemned (*nebelah*) and its use as food is not permitted. Likewise, it is forbidden to eat the meat of animals which exhibit no movement during the process of slaughter or afterwards. Animals which lie quiet and can not be made to get up by striking with a stick must not be slaughtered, according to the Jews.

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* A rabbinical expert, in consequence of the prosecution of schächten in the governmental district of Danzig, in which this method of slaughter was temporarily prohibited, testified in court that this method of slaughter was a religious observance based upon tradition and Biblical commandment (Moses, Book III and Book V, chapter 12, verse 21). In the Mosaic food laws, however, there are no provisions concerning *schachten*. The first provision concerning the *schechita* and the subsequent inspection (B'dikoh) are found in the Fifth Book of Mischna, Chapters 1 to 6. The six books of Mischna were edited on the basis of oral and written tradition by Jehuda Ha Nassi. The commentaries to the Mischna, published later and collected in the fifth century A. D., together with the Mischna, constitute the Talmud. The Mischna declares that "if the organs (lungs, trachea, stomach, heart, etc.) are permeated with holes, or have any defect, the use of the animal as food is not permitted." The Gamara of the Talmud prescribes, "if tumors or vesicles are found in the lungs, filled with air or with pure water, or with a material dry or even as hard as a stone, the use of the animal as food is permitted. If, however, there is a stinking substance, or a stinking, cloudy fluid therein, the use of the meat of these animals is forbidden. Defects and perforative openings render the consumption of the meat unpermissible under all circumstances."

2.—Bleeding after Previous Mutilation of the Medulla Oblongata by Pithing or by a Blow.

Pithing.—In practicing this method, a dagger-like knife is violently driven into the space between the occipital bone and the atlas, and thereby the medulla oblongata, the seat of the more important vital functions, especially the respiratory center and the center of the inhibitory nerves of the heart, is destroyed. The same result is obtained by breaking the neck, either by means of the hand in small animals (rabbits) or with a killing ax in the case of larger animals. On account of its more certain effect, the latter method is almost exclusively used in London in the case of wild range steers imported from America.

3.—Bleeding after Previous Stunning with a Hammer, Slaughter Ax, Slaughter Mask, and Shooting Mask.

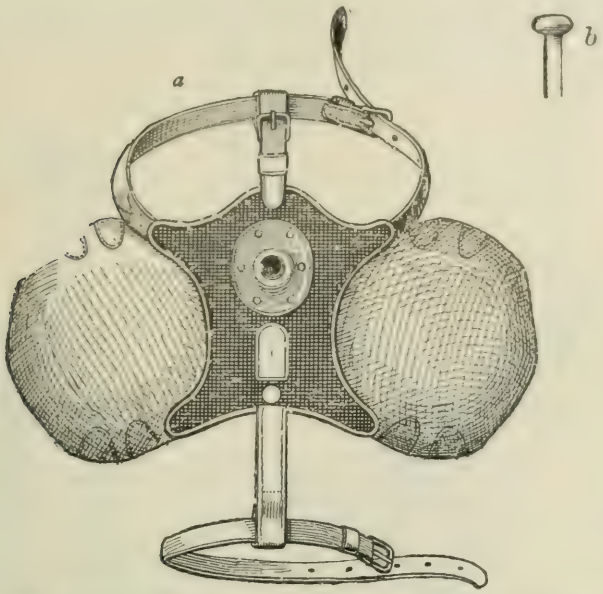
The blow with the hammer is administered with great violence upon the middle of the roof of the cranium for the purpose of producing not only a concussion of the brain, but also a fracture of the cranium. In this, as in the following method, as a result of pressure or direct injury, a rapid paralysis of the sensory and motor centres of the brain is brought about. Fick, in Würzburg, calls attention to the fact that it has been shown by extensive experience in the case of man that an immediate paralyzing concussion of the brain is accompanied with absolute unconsciousness. In place of a small hammer, the following special apparatus may be used for stunning:

(a) The killing ax, which consists of a wooden handle and a wrought iron striking apparatus fastened at right angles to the handle. One half of the latter consists of an iron cylinder about 10 cm. long and 1 cm. in diameter, the end of which forms a gouge. The other half of the striking portion is curved in order to embrace the horns of the animal to be stunned. The gouge-like end of the striking portion is driven into the middle of the roof of the cranium by a strong blow, whereupon the animal falls. In order to prevent the animal from getting up again, it is customary to introduce a rod into the opening in the cranium and to destroy the brain and medulla oblongata.

(b) The slaughter mask consists of a shield-like iron portion with an opening in the middle and with a leather attachment on either side. Furthermore, there are three thongs attached to the

slaughter mask for fastening it to the head. The opening in the shield-shaped iron portion comes to lie upon the middle of the roof

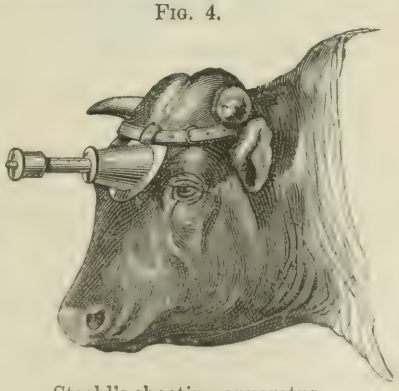
Fig. 3.



Slaughtermask as used in the Stuttgart Abattoir. *a*, mask; *b*, striking bolt.

of the cranium, while the lateral leather portion covers the eyes of the animal. As in the case of the iron cylinder of the killing ax, furnished with a gouge, a striking bolt, which is inserted into the opening of the iron portion, is driven through the roof of the cranium by a wooden hammer. In the practice of this method also, a subsequent destruction of the brain, such as occurs in the use of the killing ax, is customary.

Fig. 4.



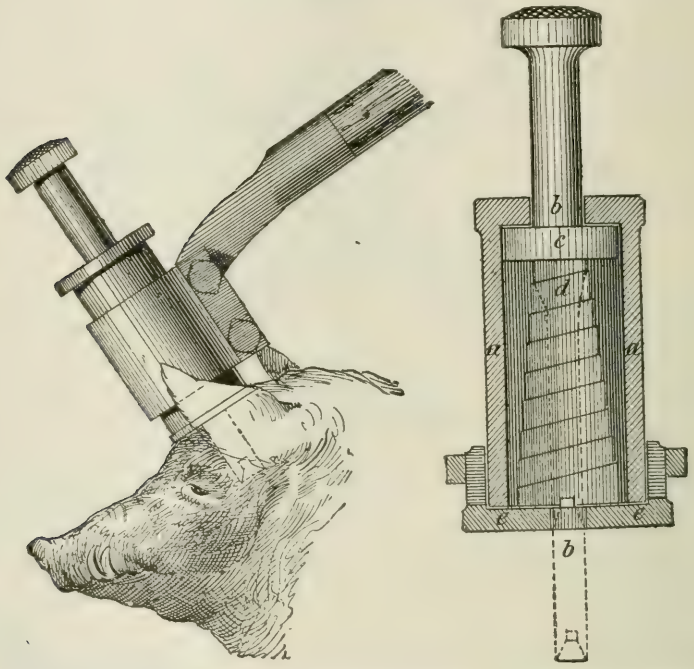
Staehl's shooting apparatus.

(c) *The shooting mask* (Siegmund).—In this apparatus, in place of the striking bolt, a short pistol barrel is used, which is screwed into the opening of the shield-like iron portion of the slaughter mask. In the posterior

part of the pistol barrel, a ball cartridge is placed, and is discharged by a light blow with a wooden or iron hammer. Subsequent destruction of the brain is not required in using the shooting mask.

An alteration of Siegmund's shooting mask is found in the shooting apparatus according to Staehl (system of "noiseless shooting"), which is shown in Fig. 4.

Fig. 5.



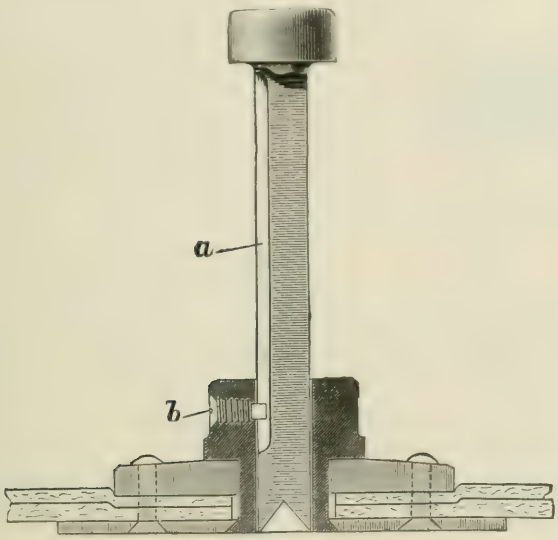
Kleinschmidt's spring bolt apparatus for killing hogs (half natural size).

(d) In using Kleinschmidt's springbolt apparatus for killing hogs (Fig. 5), death is produced in a manner similar to that with the use of the slaughter mask. A cylindrical iron bolt is driven into the roof of the cranium with the blow of a hammer. After the blow has been delivered, the bolt is thrown back into its previous position by a spring, which does not occur in the case of the slaughter mask.

Kögler, in Chemnitz, modified Kleinschmidt's springbolt apparatus in that he left out the spring and made use of a considerably shorter cylinder. The cylinder possesses a groove into which a small set screw projects. According to Kögler, the spring of Kleinschmidt's apparatus has the disadvantage that its use requires

a much more powerful blow, while the length of the cylinder (19.5 cm.) renders difficult the firm attachment of the apparatus to the head. Kögler's apparatus is without protection for the bolt and without its automatic rebound. Both these features, however, according to Kögler, are non-essential. The modified apparatus has

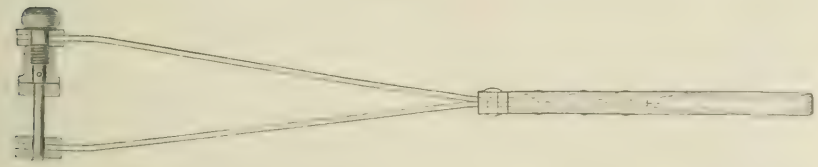
Fig. 6.



Section of Kögler's slaughter mask. *a*, groove for the bolt; *b*, screw for preventing the bolt from springing out.

given good satisfaction in various abattoirs. Kögler makes use of this method of connecting the bolt with the cylinder, such as is used in the stunning apparatus for hogs and in slaughter masks for cattle,

Fig. 7.



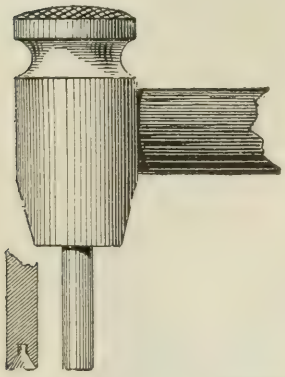
Kürten's hog killer.

and avoids thereby the possibility of the bolt springing out in the case of a misdirected blow (Fig. 6).

Kürten in turn modified Kögler's apparatus in that he divided the cylinder carrying the striking bolt into an upper and lower portion, which were held apart by a long, strong spring (Fig. 7).

Hereby, as in the case of Kleinschmidt's springbolt apparatus, the bolt is thrown back into its previous position after the blow is delivered.

Fig. 8.



Kleinschmidt's bolt-hammer for stunning calves and sheep.

(e) For Hungarian hogs, as well as for calves and sheep, the bolt hammer according to Kleinschmidt (Fig. 8) is recommended on account of the arched roof of the cranium. According to a report from Karlsruhe, however, the bolt hammer was not satisfactory for killing sheep. Better results were obtained with an oval hammer 10 cm. long. $1\frac{1}{2}$ cm. broad, flattened on both ends, and furnished with a handle 70 cm. long.

Finally, it should be noted that the firm of Renger in Arnstadt has constructed a casting slaughter apparatus for killing hogs. This apparatus serves the purpose of holding the head more securely for the administration of the blow.

Advantages and Disadvantages of the Different Methods of Slaughtering.

1. Thoracic bleeding and cutting the throat bring about a complete bleeding and thereby produce a beautiful appearance of the meat, which is associated with good keeping qualities. The blood flows out so completely since the central nervous organs are intact, and consequently the blood pressure is not lowered at the beginning. The discharge of the blood, however, toward the end of the bleeding is greatly favored by the reflex muscular contractions (bleeding or anemic spasms).

Dembo killed one rabbit by the Jewish method of slaughter and two others by bleeding after a previous stunning, and obtained the following results: (1) The rabbit killed according to the Jewish method weighed 2,000 gm. and lost 80 gm. of blood (=72 per cent.). The residual blood in the body was 28 per cent. (2) A stunned rabbit, weighing 1,950 gm., lost 50 gm. of blood (=46 per cent.). The residual blood in the body was 54 per cent.). (3) A stunned rabbit, weighing 1,850 gm., lost 30 gm. of blood (=29 per cent.), the residual blood in the body being 71 per cent. The author killed three rabbits of the same litter weighing 2,000 gm., by cutting the

throat and by bleeding after previous stunning or breaking the neck. The quantities of blood obtained were as follows: (1) In the rabbit killed by cutting the neck, 81 gm.; (2) after a previous blow on the head, 62 gm.; (3) after previously breaking the neck, 36 gm.

The results of these slaughtering experiments with rabbits can not, however, be applied directly to the large food animals, as shown by Goltz (Ztschr. f. Milch u. Fleisch Hyg., VIII), and corroborated by P. Falk. Goltz demonstrated by careful weighings that, in the large food animals, bleeding after stunning was not less complete than after cutting the throat without stunning.

In cattle the following average quantities of blood were obtained: (a) In slaughtering according to the Jewish method, 3.24 per cent. of the live weight; (b) in using the shooting mask, 3.20 per cent. of the live weight; (c) in using the striking mask, 2.89 per cent. of the live weight.

In calves: (a) In slaughtering according to the Jewish method, 4.90 per cent. of the live weight; (b) by the butcher's method of cutting the throat, 4.90 per cent; (c) by a blow with a hammer, 5.07 per cent.

In sheep: (a) In slaughtering according to the Jewish method, 4.15 per cent.; (b) by cutting the throat or severing the carotids, 4.31 per cent.; (c) by a blow with a hammer, 4.35 per cent.

Or, expressed in other words, a beef animal of 700 kg. live weight lost:

(a) In slaughtering according to the Jewish ritual, 22.68 kg. of blood; (b) by use of the shooting mask, 22.40 kg.; (c) by use of the striking mask, 20.23 kg.

A calf of 60 kg. live weight lost:

(a) In slaughtering according to the Jewish ritual, 2.95 kg.; (b) by the butcher's method of sticking without stunning, 2.94 kg.; (c) by a hammer blow, 3.04 kg.

A sheep of 50 kg. live weight lost:

(a) By the Jewish method of slaughtering, 2.07 kg. of blood; (b) by the butcher's method of killing without stunning, 2.15 kg.; (c) by a hammer blow, 2.17 kg.

P. Falk called attention to the fact that he found no difference with regard to the keeping qualities in meat preserved in cold storage whether the animals had been killed according to the Jewish method or by killing after a previous stunning.

To the thoracic bleeding and slaughter according to the Jewish method, objection is made that these methods of slaughter make a highly repulsive and grewsome impression, since they are performed

on animals while fully conscious. The act of slaughtering, however, is always a repulsive sight. Furthermore, it has been shown that animals slaughtered according to the Jewish method pass very quickly into unconsciousness (according to Zaugger, in one-half minute; according to Probstmayr, in 25 to 30 seconds; according to Esser, 40 seconds).* The respiratory and general muscular spasms which appear later are, therefore, merely reflex contractions. The death agony ceases after about four minutes.

In the case of thoracic bleeding, as well as in slaughter according to Jewish methods, the preparations for the act are repulsive, especially the rough manner of throwing cattle to be killed by the Jewish method and the unnecessarily long time the animals are kept down before the act of slaughter. These crudities, however, may be prevented by suitable regulations.

Legislative provisions for the practice of the Jewish method of slaughter.—A Meiningen circular of May 29, 1881, in harmony with the Prussian Ministerial decree of January 14, 1889, with reference to the prevention of the unnecessary abuse of animals, declares as follows:

Sec. 5. With regard to slaughter according to Israelitic custom, the following special provisions, in addition to the preceding sections 2 to 4, are in force:

1. Large animals shall be thrown only by means of pulleys or similar devices. The pulleys shall be firmly attached and the ropes used shall be strong and flexible.

2. While the animal is down, the head must be supported by proper devices, so that the battering of the head and breaking of the horns are prevented.

3. When the animal is thrown, the schächter must be present and must immediately perform the act of slaughter. This must be carried out as quickly and effectively as possible.

4. Not only during the act of slaughtering, but also for the whole period from the muscular spasms which appear after the throat is cut until death takes place, the head of the animal must be securely held.

5. Slaughter according to the Jewish method shall be practiced only by a schächter who has been approved by a ducal rabbi.

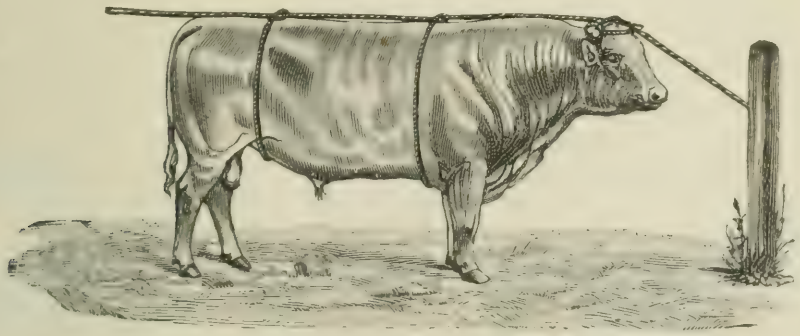
Methods of throwing.—For throwing cattle to be slaughtered according to the Jewish methods, numerous more or less complicated devices have been recommended. All these apparatus are unnecessary, since the simplest, surest, and safest method of throwing cattle consists in the so-called casting, for the practice of which nothing but a rope is required (a casting rope of about 20 metres length)

* According to more recent investigations which were undertaken by the Saxon Commission for Veterinary Service, the cornea reflex of steers and bulls slaughtered according to Jewish methods did not cease until after 3¼, 4 and 5 minutes.

(Fig. 9). Although this method of throwing was devised by German veterinarians, it was first prescribed for slaughter according to the Jewish method in Russia at the instigation of the societies for the prevention of cruelty to animals. Animals which are thrown by the method of casting lie down quietly upon the side and extend the legs in such a manner that they may be easily tied.

In Stuttgart, the former municipal veterinarian Sauer introduced an equally good method of throwing. The animals are secured by a short rope attached to the head and brought through a ring which is fastened to the floor. A short piece of rope, which is furnished with a ring in the end, is attached to each metacarpus and one end of the casting rope is fastened to the hind leg above the hoof. The

FIG. 9.



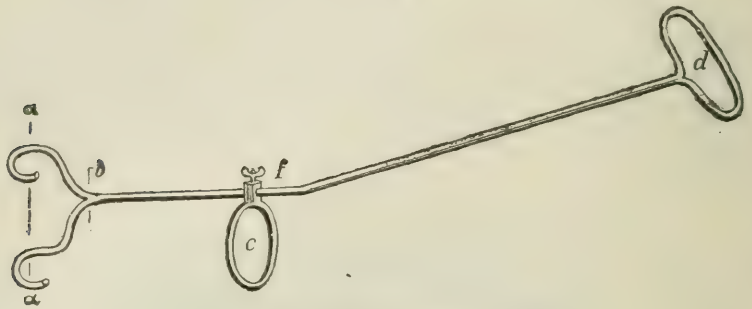
Method of throwing cattle.

casting rope is run through the rings of the ropes attached to the front legs in such a manner that the free end appears on the side of the free hind foot. The rope is tightened through a pulley and the animal falls or, rather, lies down slowly upon the side. The free hind foot, which acts as a support, prevents violent falling and floundering.

A frequent repulsive sight in slaughtering powerful steers and bulls according to the Jewish method is caused by a defective fastening of the head. It may thus occur that the animals break loose as soon as the cutting of the throat is begun and throw the head with the half-severed throat violently from side to side. To prevent this occurrence, Jakob has devised a suitable apparatus. This consists, as shown by Fig. 10, of a simple iron rod 1½ meters long and forked at one end. The ends of the bifurcation are bent back in the form of a hook. The other end is provided with a handle. A moveable iron ring, fastened by a screw, is attached to

the iron rod. The use of the apparatus consists in grasping the horns of the animal by the curved ends of the bifurcations, *a*. The point, *b*, of the apparatus, therefore, comes to lie upon the forehead. Thereupon the movable ring, *c*, on the rod is pushed over the mouth and nose, and fastened to the iron rod by means of a screw, *f*. The head of the animal is thereby held fast in the apparatus.

FIG. 10.



Apparatus for holding the head of cattle.

The apparatus of Jakob, just described, has been modified by Thielemann. Moreover, Winkler has constructed a new and very practical head fastener (Ztschr. f. Milch u. Fleisch Hyg., IV).

The blood of animals slaughtered according to the Jewish method is to be excluded from utilization as human food for the reason that it is contaminated by the stomach contents which flow out through the severed esophagus.

Prohibitions against slaughter by the Jewish method.—Slaughtering according to the Jewish method is prohibited in Switzerland and in the Kingdom of Saxony. A decree of the Saxon Ministry of the Interior, by which a petition for the removal of the prohibition against this method of slaughter was denied, is of some interest. In the conclusion of the decree it is stated, "There is no good reason to make an exception, as has been requested by the Jews, in case of the provision concerning the moral status of the matter, which is not at all concerned with religion, but simply with the consideration of the prevention of cruelty to animals; for, it is apparent that any ritual custom, of however long standing, and having its origin in variable human decrees, does not deserve any consideration if it is calculated to give moral offence, or if it is at variance with the general laws of the government. The Ministry of the Interior can not decide to allow the requested exceptional treatment of Jewish

slaughtering, especially since it would certainly be considered by the great majority of the people as an unjustifiable favor to an isolated minority."

The prohibitions against slaughtering by the Jewish method which were decreed in the Prussian governmental districts of Danzig and Marienburg, were lately removed after a decision of the Ministry of the Interior and Education upon complaint of a rabbi, and it was declared to be unpermissible to decide for particular local police districts whether cruelty to animals was involved in the Jewish method of slaughter and to forbid this method of slaughter by police regulations. On the other hand, the local police authorities in Prussia, according to a Ministerial decree issued by the Imperial Government at Düsseldorf, are authorized to prohibit any slaughtering according to the Jewish method in excess of that required for the Jewish population. The Administrative Court decided that a conditional prohibition is not permissible, and that this practice was to be forbidden or permitted to all schächters. It was further held that the various communities were authorized to pass regulations concerning the manner in which the abattoirs were to be used and concerning the procedure to be followed in slaughtering.

2. Pithing and breaking the neck furnish the least disagreeable sight for the spectator. The animals fall and remain motionless. On the other hand, pithing has been rightly characterized by Gerlach as most gruesome, since by this act consciousness remains intact until it is destroyed by the cerebral anemia in consequence of the loss of blood. Moreover, the methods of pithing and breaking the neck have the great disadvantage that bleeding is incomplete. In the medulla oblongata are found the vital center, respiratory center, regulative center for heart action, the dominating vasomotor center, and the center of muscular contractions. By mutilating the medulla oblongata these centers are destroyed, and thus all the important factors in thorough bleeding, respiration, heart action, and reflex muscular contractions are eliminated. The animals bleed to some extent, as Schmidt-Mülheim states, into their own blood vessels.

In the government districts of Gumbinnen and Düsseldorf, the killing of cattle by pithing is forbidden, and the same is true for the whole Russian Empire, in which it was previously the exclusive method of slaughter. The abandonment of pithing as a method of slaughtering in Russia was chiefly brought about by the experiments of Dembo, who showed that pithed steers still ate salt and bread which was offered to them.

3. As the best and most humane method of slaughter, we must consider those methods in which the animals are bled after being stunned. The manner in which the stunning shall be accomplished is of no consequence. Skilled butchers kill an animal by a hammer blow as quickly and as certainly as by means of a killing ax, slaughter mask, or by any other stunning instrument. The use of the hammer, especially in the case of hogs, is simpler than that of slaughter apparatus. In Berlin, for example, cattle and hogs are killed exclusively with a hammer or with the head of an ax. With less experienced persons, the slaughter mask or the apparatus of Kleinschmidt and Kögler render the blow more certain than that with a hammer. The use of this apparatus requires, however, more time and an assistant in the slaughter of hogs, which is not necessary in using the hammer. These facts are to be considered in slaughtering on a large scale.

The killing ax requires for its exclusive use considerable skill. The slaughtering mask is frequently unsatisfactory for killing bulls. The animals either do not fall at all or plunge, and spring up again and struggle. The use of the shooting mask, moreover, is not without danger. Thus, a few years ago a butcher's apprentice was injured in an accident with a shooting mask of the old kind, and another accident happened in the abbatoir of Erfurt in the use of Staehl's shooting apparatus. The ball passed outward under the left ear of the animal and shattered the femur of the assistant who was standing by the head of the animal. Moreover, the bleeding of the animals may be incomplete in case the bullet injures the medulla oblongata, and, finally, the meat is injured if the bullet penetrates the cervical musculature. All these accidents, however, may be avoided by the skilful use of the apparatus, as is contended by Mittermaier, one of the most enthusiastic advocates of the introduction of the shooting apparatus for killing animals, from observations made in Heidelburg and Swiss abbatoirs, in which all of the larger food animals and, in recent times, also hogs, are shot. In some abbatoirs, as in that at Potsdam, the shooting is done by an employee of the abbatoir (hall master), whereby accidents have thus far been avoided.

The methods which require a previous stunning, when properly practiced, satisfy completely humanitarian sentiments in so far as the first violent assault is followed by a paralysis of the sensory centres of the nervous system. Moreover, they serve the interests of meat hygiene, since, in consequence of the integrity of the medulla oblongata, a thorough bleeding is not prevented. Only when, after

the use of the killing ax or slaughter mask, not only the cerebrum but also the medulla oblongata are destroyed by the introduction of a rod, is bleeding checked in a manner like that which occurs in pithing and breaking the neck. This may also occur, as already mentioned, in shooting animals.*

The slaughtering methods in which bleeding follows stunning, in spite of their advantages, are not much in vogue. In a large proportion of the abbatoirs in various parts of Germany, it is allowable to kill sheep and calves by thoracic bleeding or cutting the throat without previous stunning. It is difficult to understand why these animals should not be allowed the benefit of a previous stunning in slaughter. The procedure of communities which make obligatory the stunning of all food animals, including those from which man has nothing to fear, deserves all recognition.

Two notable regulations (Duchy of Meiningen, of May 23, 1891, and the Kingdom of Saxony, on March 21, 1892) prescribe that, in the slaughtering of all animals, stunning must precede the removal of the blood. The only exception is in the case of fowls. The Saxon regulation, which, as shown on page 142, does not accept the Jewish method of slaughter, prescribes as follows concerning the act of stunning: In the case of cattle, stunning shall be accomplished by the use of the slaughtering mask, except in young animals where the incomplete development of the skull renders it unnecessary. With reference to the stunning of hogs, calves and sheep by a blow upon the head or neck, the choice of a stunning apparatus is left to the discretion of the butchers, although the wooden hammer is recommended for calves, the bolt apparatus for hogs, and the striking bolt hammer or a blunt ax for sheep.

4.—Order of Procedure in Commercial Slaughtering.

After the death of the animal, skinning takes place in the case of horses, cattle and sheep, and scalding and singeing† in the case of hogs, while calves are immediately hung up for exenteration.‡

* According to Siegmund, it is desirable to bleed animals which have been shot, not immediately, but after a lapse of from one to three minutes, since then bleeding will be thorough and rather more so than in slaughtering by the Jewish method, in which the trunks of the carotid arteries often become closed very quickly.

† The meat of singed hogs is said to keep better than that of scalded hogs. Singeing, however, renders the inspection of the skin more difficult.

‡ Calves, especially young and poor specimens, are preferably sold in the skin, in order to prevent the drying of the meat, whereby it becomes of a lighter color and of a less desirable appearance.

Thereupon, after making a cut along the middle of the inferior abdominal wall, the exenteration of the body cavity takes place in such a manner that first the intestines and then the stomach are separated from their natural connections. The intestines are all removed, together with the mesentery. The spleen, in the case of cattle, is left in connection with the stomach; in hogs, with the mesentery; while in calves and sheep the spleen remains in the body. The liver in horses and cattle is removed separately. In all other kinds of food animals it is taken out in its natural connection with the lungs and heart (the so-called sling), or is removed from the body cavity without splitting the sternum, or after a previous opening of the thorax. The latter process is required in the interest of an accurate inspection.

In hogs, after the above described operations, the separation of the retro-peritoneal fat tissue occurs, and with it that of the kidneys. This separation is necessary in order that a thorough inspection of the abdominal musculature for cysticerci, calcareous concretions, hemorrhages, etc., may take place. While horses, cattle, calves and sheep are being skinned, the lower portions of the extremities are also separated from their connections below the carpal and tarsal joint. As a rule, the exenteration of the bladder, uterus and rectum takes place immediately after the removal of the intestines.

With the exenteration of the abdominal, pelvic and thoracic cavities are connected the removal of the brain from the cranial cavity, and the separation of the tongue from its muscular connections with the lower jaw, so that the cranial cavity and the mouth and pharyngeal cavities are laid open. Finally, in the case of horses, cattle and hogs, the trunk is divided into two halves by splitting the spinal column.

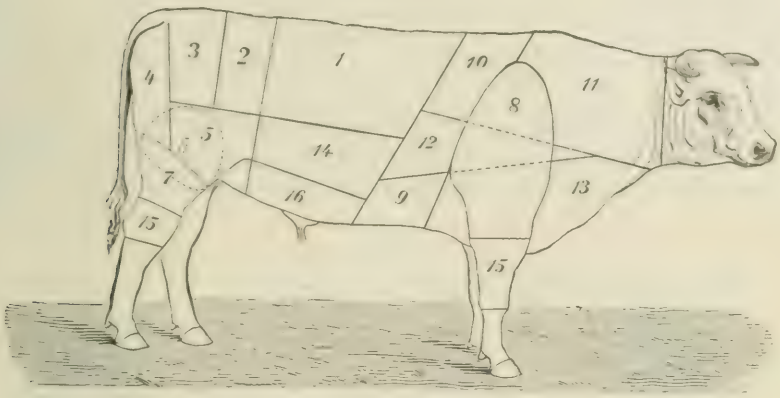
Further procedure in dissection, according to ordinary methods of butchering, is different in different food animals.

In cattle, after a previous quartering,* the more valuable cuts of meat are sold separately. As the more valuable parts, we have the purely muscular portions of the body, which contain only small quantities of bone and sinew. As less valuable parts, on the other hand, we have the portions which are poor in muscle, but strongly infiltrated with fat tissue (tallow), and which contain a large proportion of bone and sinew. This distinction finds expression in the

* Quartering is not practiced in a uniform manner. In Northern Germany the fore quarter is usually separated from the hind quarter between the ninth and tenth ribs, thus leaving three ribs on the hind quarter: while in Southern Germany the separation takes place before the next to the last rib.

different prices. The so-called fillet universally brings a higher price than the other muscular parts; in London and Paris, for example, three to four times as much as the thin abdominal meat.

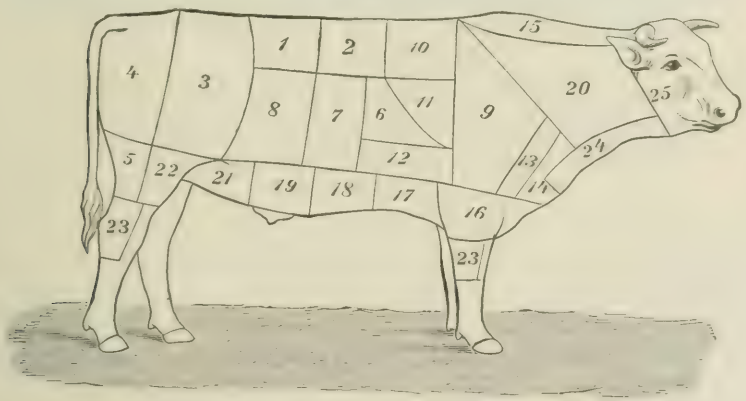
Fig. 11.



Classification of beef in Berlin.

I. Quality: 1, Rinderbraten; 2, Blume; 3, Eckschwanzstück; 4, Mittelschwanzstück; 5, Kugel; 6, Oberschale.
II. Quality: 7, Unterschwanzstück; 8, Bug; 9, Mittelbrust.
III. Quality: 10, Fehlrippe; 11, Kamm; 12, Querrippe; 13, Brustkern.
IV. Quality: 14, Quernierenstück; 15, Hessen; 16, Dünnung.

Fig. 12.



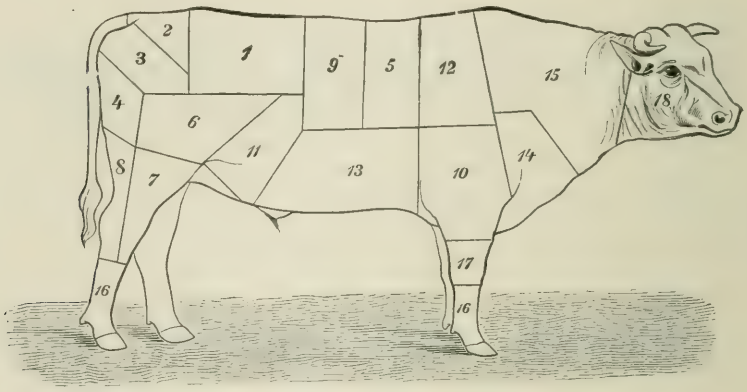
Classification of beef in Vienna.

I. Quality: Lungenbraten (nicht eingezeichnet): 1, Beiried; 2, Ried (Rostbraten); 3, Hüferschwanzl; 4, Geschnittes Schwanzl; 5, Ortschwanzl; 6, Rieddeckel; 7, Zwerchried; 8, Schlemmried (Riedhüfel).
II. Quality: 9, Schulter; 10, Dicker Spitz; 11, Kruspelspitz; 12, Mageres Meisl; 13 und 14, Fettes Meisl; 15, Kamm; 16, Brustkern; 17, Dickes Kügel; 18, Mittleres Kügel; 19, Dünnes Kügel; 20, Tristl; 21, Bauchfleisch.
III. Quality: 22, Zapfen; 23, Wadschinken; 24, Stich; 25, Backen.

Otherwise, the purely muscular parts exhibit no noteworthy differences in the protein content. While, therefore, in ordinary traffic various prices customarily prevail for these parts, this must be explained, not by the higher nutritive value of particular parts of the meat—as a rule, the consumer does not inquire at all concerning the nutritive value—but by the better flavor which is due to the tender character of the fibers and the content of extractives (see page 196).

According to Ignatiev, the valuation of the meat corresponds to the unequal distribution of two albuminoid substances in the musculature, myosin and myostromin (the essential components of the

Fig. 13.



Classification of beef in London.

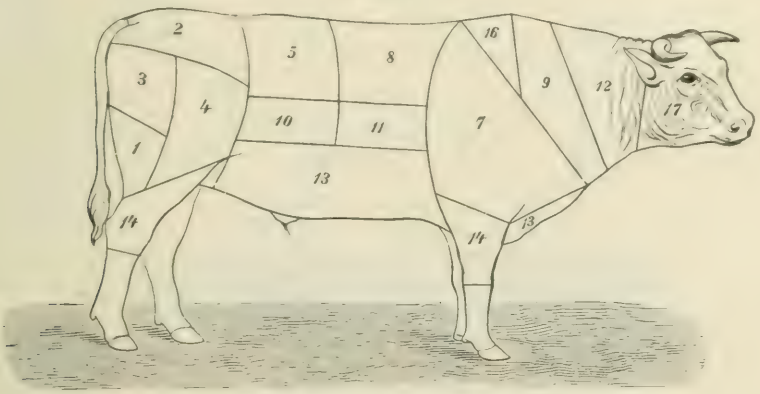
I. Quality: 1, loin; 2. aitch bone; 3 and 4. silverside; 5. fore rib.
II. Quality: 6, top side; 7, leg; 8, street; 9, mid rib; 10, shoulder.
III. Quality: 11, thin flank; 12, chuck; 13, fore quarter flank.
IV. Quality: 14, brisket; 15, clod and sticking; 16 and 17. shank; 18, cheek.

muscle mass, according to Danilewski). The more work which the muscle has performed, the poorer it is in the former and the richer in the latter. The relative quantity of both substances, according to Ignatiev's investigations, is so distributed according to the region of the body that the myosin decreases from the head toward the tail, while the myostromin increases. The latter exists in large proportions in the parts below the vertebral column.

Classification of beef.—The most expensive cuts of meat are : The lumbar muscles, iliopsoas, quadratus lumborum and diaphragmatic columns ("lungenbraten," "lummel," fillet), the dorsal muscles with their bony foundation, sacro-lumbalis and longissimus dorsi (roast,

sirloin, porterhouse), the muscles of the croup and thigh (rump, hip, leg), the musculature of the scapula, together with the humerus and forearm (shoulder), the musculature above and below the shoulder on either side of the withers (spare ribs), the thicker parts of the abdominal muscles (cross ribs), and the sternum with the connected soft parts ("beef breast"). The cheapest cuts of meat are the thinner portions of the abdominal muscles (flank), the cervical and cephalic muscles, and also the muscles of the elbow and hock. The remaining groups of muscles receive different valuations in different regions. Everywhere, however, the hind quarters are more highly prized and bring a higher price than the fore quarters.

FIG. 14.



Classification of beef in Paris.

I. Quality: 1 and 3, semelle; 5, culotte; 4, tende de tranche sous la semelle; 5, aloyau; 6, filet (not shown).
II. Quality: 7, plats de côtes découverts sous l'épaule; 8, entre-côtes et côtes; 9, talon de collier; 10, bavette d'aloyau; 11, plats de côtes couverts.
III. Quality: 12, collier; 13, pis; 14, gîtes.
IV Quality: 16, surlonges; 17, plats de joues.

The latter serve especially in the preparation of meat broths and sausages, and are, therefore, characterized as "soup meat" and "sausage meat." The Israelites are required by their food laws to eat only the fore quarters of food animals, and are allowed to eat the hind quarters only after they are "geporcht," that is, when the large vascular trunks are removed. (According to Goltz, this custom is based on the 32nd chapter of the first Book of Moses, in which the struggle of Jacob with the angel is described. The angel dislocated Jacob's hip, "Therefore, the children of Israel eat no sinews in the hip joint to the present day, since the sinews in the hip joint of Jacob were touched.")

Classification in Berlin.—After the removal of the fillet and the tongue, the remainder of the muscular trunk, together with the extremities, is cut up according to four principal qualities and sixteen sorts (Fig. 11):

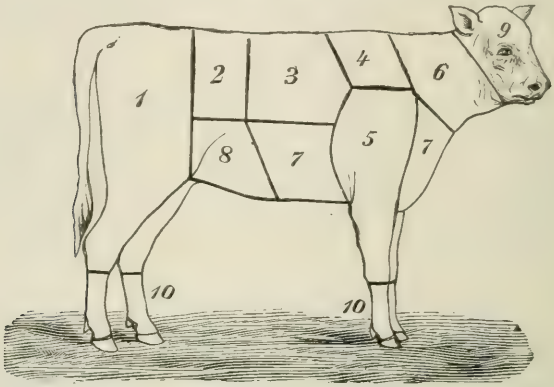
I.—(1) Roast, (2) prime, (3) corner rump, (4) middle rump, (5) round, (6) upper round.

II.—(7) Lower rump, (8) shoulder, (9) middle breast.

III.—(10) Spare rib, (11) neck, (12) short ribs, (13) fore breast.

IV.—(14) Cross kidney, (15) Hessian (knee joint), (16) flank.

Fig. 15.



Classification of veal.

I. Quality: 1, leg; 2, loin roast.
II. Quality: 3, back; 4, withers; 5, shoulder.
III. Quality: 6, neck; 7, breast; 8, flank.
IV. Quality: 7, head; 10, feet.

Classification in Vienna.—According to a private communication of Toscano, three chief qualities and twenty-four sorts are distinguished in Vienna:

I.—(1) Lungenbraten, (2) side roast, (3) roast, (4) hüferschwanzl, (5) gschnattes schwanzl, (6) ortschwanzl, (7) rieddeckel, (8) zwerchried, (9) schlemmried (riedhüfel).

II.—(10) Shoulder, (11) thick point, (12) crust point, (13) poor cut, (14) fat cut, (15) neck, (16) fore breast, (17) thick round, (19) thin round, (20) tristl, (21) flank.

III.—(22) Plug, (23) hock joint, (24) stick piece, (25) cheeks.*

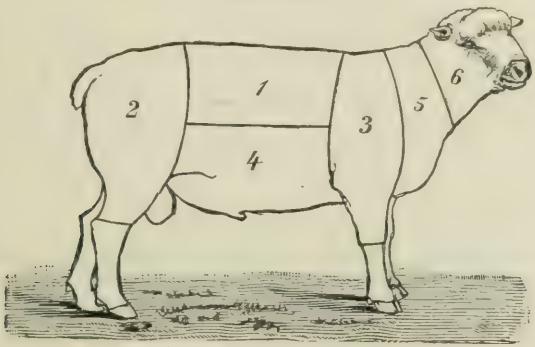
* In Vienna, an especially high value is placed by certain admirers of the muscular part of the diaphragm upon the so-called crow or crown meat. The crown meat is much prized also in Southern Germany, especially in Bavaria. In Munich there is a special crown meat establishment in which this meat is prepared, as a kind of delicacy, by boiling.

The classifications of meat in London and Paris are apparent from the accompanying illustrations. Calves are cut up as required.

Classification of veal.—In the calf, the greatest value is placed upon the muscle mass of the hind quarter (leg), of the back (loin roast, back, cutlet), the withers (corresponding to the "spare rib" of cattle), while the shoulder, neck, breast and flank produce a smaller value.

On the market the thymus of calves (sweetbread) is reckoned as meat, and is sold at a comparatively high price. The thymus of calves is a food which is readily digested, on account of the lactic acid which it contains. It possesses also considerable nutriment in

FIG. 16.



Classification of mutton.
I. Quality: 1, back: 2, leg.
II. Quality: 3, shoulder.
III. Quality: 4, breast and flank; 5, neck; 6, head.

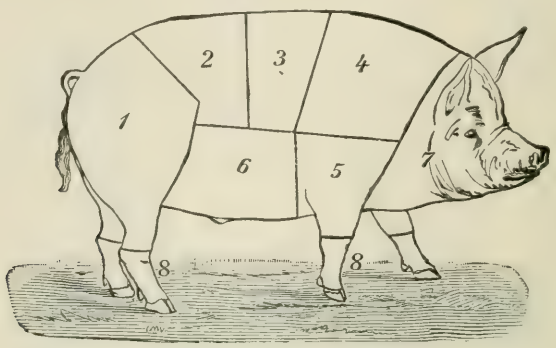
the form of albumen and fibrin. Milk calves furnish an especially large and valuable thymus, while that in calves which are reared artificially are less valuable. The weight of a thymus varies between 200 and 2,000 gm. The thymus of adult cattle is worthless. It possesses a leathery consistency, and is often sandy in consequence of a deposit of carbonate and phosphate of lime in the glandular substance.

In preparing a sheep carcass for sale, a transverse cut is made in such a manner that the fore quarters with the neck, thorax and abdominal muscles form one part, while the juicy back with the legs form another part. No further classification occurs in cutting up the sheep. (Fig. 16.)

Hogs are first separated into two lateral halves by a dividing plane extending from the head to the tail. Thereupon the legs or

hams (the most valuable part of the hog) are separated, and then the separation of the halves of the head (cheeks) and the lower portions takes place. The remaining part of the halved trunk, together with the anterior extremities, is divided into an upper and lower portion by a cut extending backward and upward from the shoulder joint. Thereby the abdominal musculature is left on the lower portion. The upper part furnishes the hog back (carré), or the "carbonade meat," the meat of the roast ribs (cutlets), the so-called spare rib and the withers, while the under portion furnishes the shoulder, the breast piece and the flank ("sides, smoked meat").

FIG. 17.



Classification of pork.

I. Quality: 1, ham; 2, loin; 3, cutlet.
II. Quality: 4, withers; 5, shoulder and breast.
III. Quality: 6, flank.
IV. Quality: 7, head with cheeks; 8, feet.

Zschokke, in a very noteworthy work, condemns, as an evil practice, the habit of butchers in cutting into various kinds of pathological tissue, especially tuberculous areas; also the habit of holding the knife between the lips or teeth. In this connection it should not be forgotten that butchers represent a considerable contingent to the number of human beings who die of tuberculosis. The practice of artificial respiration, during which the assistant stands upon the slaughtered animal and stamps upon the abdomen and thorax, is to be characterized as a bad habit and should be forbidden, since the stomach contents may thus be forced through the pharyngeal cavity into the trachea and bronchi. Likewise, washing the lungs in impure water, washing the meat, and, finally, "drawing out the blood" in cases of incomplete bleeding, which is really only an extraction of blood coloring matter by allowing the meat to lie in water, should be forbidden as highly improper.

IV.

INSPECTION OF SLAUGHTERED ANIMALS.*

General Discussion.—It is desirable that the expert be present in person at the slaughter, in order to make it impossible from the beginning for the tradesmen to attempt any removal of pathological products, or the presentation of healthy organs in the place of diseased ones. A supervision of slaughter is also desirable, for the reason that exudations and transudations into the body cavity flow out during the process of slaughter, and thus escape the notice of the expert inspector if he does not begin inspection until after the slaughter is complete. Moreover, it should not be forgotten that butchers understand very well how to conceal certain alterations. Thus, one may observe in abattoirs how, by careful washing, butchers remove the ichorous contents of the peritoneal cavity in cases of perforative peritonitis of calves, and how they remove the fibrinous deposit by pulling or scraping it off, and in this manner render the real condition, which was quite striking, very difficult to recognize. The same may be said in cases of pleuritis, pericarditis and metritis.

The practice, which has become especially prevalent, of removing abscesses and certain parasites (echinococci) in and upon organs, tuberculous masses on the serous membranes, exterior surface of organs and in the lymph glands, should be checked by severe punishment. Fortunately, we are in a position to demonstrate easily such attempts to obscure the actual condition in diseased animals. The removal of masses of material from different organs is evidenced by loss of substance. Thus, the frequently practiced removal of the pleura on account of tuberculosis or inflammatory alterations, especially in meat which is introduced from foreign countries, is to be recognized by the fact that the ribs and intercostal muscles come to be exposed and are not covered by a glistening membrane. In the place of the smooth, glistening, transparent pleura, there appears a

* In this chapter only macroscopic meat inspection will be considered. Microscopic inspection for trichina is discussed in connection with the account of trichina.

more or less conspicuous sub-pleural connective tissue, which has become cloudy and opaque on account of the introduction of air (artificial emphysema). The nature of the pathological process in the removed pleura is, under these conditions, still recognizable from the fact that the lymph glands, which lie in the entrance to the thorax and are surrounded by fat tissue, exhibit alterations.

Quite frequently also the uteri of cows filled with well developed fetuses are laid aside in order to make use of the meat of so-called unborn animals as a human food material. To prevent this underhand dealing, all inspected uteri are to be cut up and condemned. In this way the removal of pregnant uteri becomes impossible, since for each slaughtered cow an intact uterus must be presented.

If the inspector can not be present at the slaughter of all animals (as, for instance, in small slaughterhouses where no expert inspector is present, or in very large slaughterhouses with extensive operations), it should be required that all organs should remain in the slaughtered animal as nearly as possible in their natural condition. At any rate, the spleen, kidneys, liver, lungs, heart and udder, as well as the skin (the latter on account of description for legal purposes) should not be separated. In so far as exenteration cannot be avoided, the organs must be left in their natural connection with one another. In case several animals are slaughtered at the same time, the exenterated organs should be hung up near the animal body to which they belong, in such a manner that no interchange is possible. Furthermore, no organs should be removed before the inspection is completed. It should also be forbidden that any sort of alteration, such as scalding the stomach, mesentery, hides, feet, etc., be undertaken in any of the separated parts of the animal before they have been subjected to expert inspection.

Finally, meat inspection should be performed, so far as possible, by daylight, since by artificial illumination finer alterations may escape the notice of the inspector. Moreover, in illumination by gas even the acute stages of icterus are usually overlooked. The government president at Posen, in view of the fact that an accurate judgment of slaughtered animals is, as a rule, possible only in daylight, decreed on June 15, 1896, that in future the inspection of animals slaughtered in public slaughterhouses of the governmental district of Posen should be performed only by daylight. Exceptions from this decree are allowed only in case the abattoir is lighted by electricity or by some other artificial source of light

which, in the judgment of the official veterinarian, is of equal intensity. The official veterinarians are instructed in making their regular inspection of public abattoirs to give special attention to this decree.

Chief Points in Inspection.—The most important characters of the normal or pathological condition of organs are size, color, sheen, conspicuousness or inconspicuousness, as well as uniformity or lack of uniformity in the macroscopic structure, blood content of the cut surface and consistency. Attention should be given to these characteristics in each organ. All organs are to be carefully inspected and palpated. Certain parts, as, for example, the lymphatic glands at the points of introduction of tuberculous infection, are always to be examined by means of an incision, but other parts, on the contrary, only in case of the suspicion of an alteration.

Stamping Inspected Animals.—All organs as well as the meat are to be marked after inspection is completed with an indelible stamp, in order to exclude the possibility of presenting organs which have already been inspected in the place of fresh diseased organs. Moreover, the stamping of inspected organs and cuts of meat render it possible for consumers to buy only inspected meat, and offers the sanitary police a means of demonstrating evasions of meat inspection. For stamping fresh meat, non-poisonous, quickly-drying and adhesive colors are to be used. Pickled and smoked meat should be marked with a branding stamp.

Condemnation.—Diseased animals and parts, or those which are suspected of being diseased, should be condemned preliminarily by a formal act. In Berlin this is done by pasting on a label with the inscription, "Preliminarily rejected and condemned, Dr. ——, Municipal Veterinarian." In case of final condemnation and exclusion from consumption, the animals or parts in question must be removed to an official inclosure (sanitary slaughterhouse) and there be disinfected under official control. If, however, the animals or parts which were preliminarily condemned may be sold under declaration as spoiled food material, in the sense of the food law, this quality is to be characterized by a special stamp, "spoiled, non-marketable, or inferior value, freibank meat." The sale of the last named meat must take place under official supervision. (Compare page 48.)

Illegal Removal.—According to Sec. 137 of the Criminal Law Statutes, imprisonment not to exceed one year is prescribed for intentional concealment, destruction, or complete or partial removal of meat which has been condemned by the competent authorities or officials. The Imperial Court (Decision II. Criminal Senates, May 30, 1884) decided that the city veterinarians in Berlin, according to the text of Secs. 16 and 34 of the local regulations for the enforce- of condemnation, were competent in the sense of Sec. 137 of the Criminal Statutes. According to the meat inspection law, condemnations are reserved for the police authorities. (See page 84.)

Inspection of Diseased Organs.—With regard to the practice of the inspection of diseased organs, the statement of Zschokke deserves all commendation. "By no means should the detailed inspections of pathologically altered organs take place in the public portion of the slaughterhouse, and with the ordinary instruments used for other purposes. For, by means of such instruments and by contaminated hands the contagion may be most easily spread. Since, moreover, meat may always serve in turn as a nutrient medium, it is not improbable that bacteria on it, even if they do not develop, still remain alive and may be disseminated. The danger of infection of man by the meat of tuberculous animals consists, perhaps, less in the eating of it—since for the most part it is heated to such a degree that bacteria are thereby killed—than in manipulating it during its preparation for consumption. We have to consider especially the possibility that bacteria may float in the air, and in other ways may gain entrance into the human organism. It requires no special argument in this connection to show that the subsequent washing of instruments and hands, as it is commonly done, furnishes no guaranty against infection."

Course of Inspection.—The inspector must make it a rule to follow a certain course in the inspection of the various parts of slaughtered animals in order that no organ may unintentionally be overlooked, and that in every case all organs may be subjected to inspection. The following may serve as a guide for the process of inspection, which obviously may be altered at will with regard to the sequence of the organs.*

* Thus, many experts begin with the inspection of the fore quarters, and then undertake the inspection of the head, internal organs and skin.

(A) CATTLE.—(For horses, the same procedure may be adopted with a few variations.)

1. *Skin.* Wounds, abscesses, actinomycomata, anthrax—carbuncles, abnormal blood content of the inner surface; in the horse, especially, glanderous processes and botryomycomata.

2. *Head.*

(a) Outer aspect. (Actinomycomata.)

(b) Alæ nasi; lips, hard gums, pharyngeal cavity. (Foot-and-mouth disease, rinderpest.)

(c) Tongue. (Foot-and-mouth disease, actinomycosis — palpate.)

(d) External and internal masticatory muscles. (Cysticerci—make an incision.)

(e) Upper cervical and laryngeal glands. (Tuberculosis, actinomycosis.)*

For the complete inspection of the head, the inspection of the tongue with its connections with the rami of the jaw is required.

If rustling respiratory sounds were perceptible during life, the nasal cavities should be inspected after a previous splitting of the head in the median line. In horses the nasal cavities are always to be inspected (glanders).

3. *Liver.* Examination by inspection, palpation, and making an incision into the portal glands. (Degenerations, inflammation, parasites, tumors, tuberculosis, etc.) Furthermore, an incision above in the right lobe and on the posterior surface in the middle of the left lobe, and, finally, along the lobus spigelii, as far as the large bile ducts. (Liver flukes.)

4. *Heart.* Inspection after opening the pericardium, opening of the left and right ventricle in the manner customary in post mortems. (Degenerations, hemorrhages, endocarditis, cysticerci, echinococci.)

5. *Lungs.* Palpation, incision in a transverse direction; incision of the mediastinal and bronchial glands. (Tuberculosis, echinococci, Strongylidæ, inflammations, aspiration of blood and stomach contents.)

6. *Spleen.* Palpation; incision of the splenic lymph glands. (Swelling, echinococci, tuberculosis.)

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* All lymphatic glands lying on the digestive and respiratory apparatus are to be examined for the presence of tuberculous alterations by making an incision.

7. *Kidneys.** Inspection or incision extending from the middle of the convex border to the renal pelvis, incision of the renal lymph glands. (Degenerations, inflammation of the renal pelvis and kidney itself, parasites, tuberculosis.)

8. *Stomach.* Internal and external surface. (Inflammations, tumors, parasites, actinomycomata, serous tuberculosis.)

9. *Intestines.* (Inflammations, parasites, hemorrhages, gelatinous infiltrations, intestinal anthrax, tuberculosis.)

10. *Mesentery.* Incision of the mesenteric gland (hemorrhages, pentastomes, tuberculosis.)

11. *Omentum.* (Hemorrhages, tuberculosis.)

12. *Testicle or uterus.* Cutting open the latter. (Inflammations, tuberculosis.)

13. *Urinary bladder.* Inspection, and press out the contents. In order not to destroy the value of the bladders unnecessarily, they should be cut only in cases where disease is suspected. (Erythrism, cloudy contents, thickening.)

Hereupon follows:

14. *Inspection of the four quarters.*

(a) External aspect. (Blood content, hemorrhages, edema, tumors, parasites [cysticerci]). All hemorrhages observed upon the surface should be examined to determine whether they extend deeply into the meat. Bone fractures are often characterized by only slight suggillations on the surface of the skinned carcass. In female animals the udder is to be examined while inspecting the hind quarters, the supramammary lymph glands should be incised. (Tuberculosis, actinomycosis, abscesses.)

(b) Inner aspect, peritoneum, pleura. (Blood content, inflammation, tumors, tuberculosis.) The diaphragm should be lifted, since otherwise in the hanging animals the alterations which are found underneath the diaphragm might be easily overlooked.

(c) Spinal column, pelvis and sternum. (Discolorations, fractures, osteo-myelitis, tuberculosis.)

Finally, in case cerebral or motor disturbances were observed in inspecting the animals before slaughter, the brain or the extremities (hoofs, bones, tendons, joints) are to be subjected to a careful inspection.

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* The kidneys are best separated from the fatty capsule immediately after slaughter, before it has set, and, until inspected, should be left in their natural connection with the hind quarters by means of the urethra.

(B) CALVES.—In calves, inspection takes place in the same manner as with cattle, with the exception that the inspection of the liver for flukes is omitted. Especial attention in calves should be given to the condition :

1. Of the stomach (ulcus pepticum.)

2. Of the small intestine (hemorrhagic enteritis, dysentery).

3. Of the mesenteric and portal glands (congenital and incipient tuberculosis).

4. Of the navel (omphalo-phlebitis).

5. Of the joints (septic and suppurative polyarthritis).

(C) SHEEP.—In sheep the spleen must be carefully inspected in every case (anthrax); also the brain (*Cœnurus cerebralis*). Moreover, in sheep, attention should be given to the frequently occurring lung and stomach worms, as well as to sarcosporidia in the esophagus and skeletal musculature.

(D) HOGS.—The internal organs, spinal column, pelvis and sternum are in general inspected in the same manner as in cattle. The liver, lungs, heart, trachea and tongue of hogs are to remain in their natural connection. The following variations from the above described course of inspection requires consideration in the case of hogs :

1. Careful inspection of the tongue and heart as well as the abdominal muscles, free from retroperitoneal fatty tissue; diaphragm; intercostal, cervical, masticatory and laryngeal muscles for the presence of cysticerci.*

2. An incision into the base of the lungs on account of the frequent occurrence of *Strongylus paradoxus.*

3. Inspection of the skin. (Erythrism, granular eruptions, sclerosis in boars.)

4. Inspection of the udder (actinomycosis).

5. Inspection of the hoofs (foot-and-mouth disease).

6. Inspection of all visible skeletal muscles (hemorrhages, cysticerci, calcareous concretions).

Inspection may proceed in this way in ordinary cases. If pathological alterations are found, the findings of inspection are to

* In order that the cervical muscles may be inspected for cysticerci, it is desirable that all hogs should be split before inspection; that is, separated into two lateral halves by a longitudinal splitting of the spinal column and the associated soft parts.

be supplemented according to requirements by determining the condition of other organs and, if necessary, by microscopic, bacteriological and chemical tests. The extent to which this is indicated will be especially discussed in connection with the various diseases.

Appendix.—Inspection of Imported Meat.

The inspection of meat which is introduced in a slaughtered condition from any locality inland or from a foreign country is always uncertain, for it must be done by the inspector without a knowledge of the condition of the animal before slaughter, and, therefore, can not include all of the internal organs. Certain organs, as, for instance, the stomach and intestines, can not be introduced in connection with the carcasses, since they rapidly pass into decomposition and cause an extension of this process to other parts of the body. Often, however, there are pathological processes in the stomach and intestines which may render the meat injurious to health (septic inflammation of the stomach and intestines, dysentery). It is easy to understand, therefore, why Hartenstein proposed that imported meat should be offered for sale only in separate booths, as required by the Prussian slaughterhouse law, and that labels should be attached to these sales booths with the inscription, "Introduced from outside countries. No responsibility can be assumed for the harmlessness of the meat." The same purpose is served by a special stamping of introduced meat, so as to make it apparent that the meat is introduced.

Naturally, the inspection of meat introduced from foreign countries is not entirely without value, as is shown by the findings of trichinæ in pork introduced from America, and which had been already inspected in the export country. Beside trichinæ, macroscopically-visible injurious parasites (beef and pork measle worms) may be demonstrated if those parts which serve as a favorite location for these parasites are introduced in their natural connection with the animal bodies. For the detection of the beef measle worm, the head is of prime importance, and for the demonstration of the pork measle worm, the heart and tongue. It is absolutely necessary to have the head with the lower jaw, together with the masticatory muscles, along with the imported meat, since more than 90 per cent. of all findings of beef measle worms are possible only

through an inspection of the masticatory muscles. For inspection for glanders, the head and skin are indispensable. For the diagnosis of tuberculosis, pleuro-pneumonia, cattle plague and swine plague, the lungs should be imported along with the meat, and for the determination of anthrax and Texas fever the spleen should be presented. For the detection of septic and pyemic diseases and generalized tuberculosis, the introduction of the heart, liver and kidneys should be required. In female animals, in view of the importance of septic diseases of the udder and uterus in forming a judgment of the meat, the introduction of these organs is desirable. If the introduction of the uterus must be abandoned on account of the difficulty of transporting it when filled by a fetus, the instructions for inspection of introduced meat are to be so worded that all carcasses of female animals in which an inflammation of the lymph glands, which correspond to the uterus, is demonstrated shall be excluded from the market. It is, moreover, self-evident that individual parts of bodies and organs to be imported shall not be removed before inspection is completed, and that individual pieces, sausage, canned meat, and other mixtures of minced meat which can not be subjected to an inspection, shall be absolutely excluded from introduction. (Compare Sec. 12 of the Meat Inspection Law.)

Since expert inspection and the proper utilization of the findings in the case of meat introduced from outside countries belong to the most difficult functions of meat inspection, this part of the inspection should be reserved for veterinarians. Furthermore, in cases where a diseased condition is suspected, all means are to be exhausted in making a more accurate inspection (histological, bacteriological and chemical methods of testing), in order that, so far as possible, only unexceptionable and actually marketable meat shall leave the inspection stations for introduced meat.

The quite generally practiced market control of introduced meat in the inland, and the thorough secondary inspection of fresh meat introduced from other localities which have been reserved for cities with public slaughterhouses, do not possess as much significance since the meat inspection law has come in force as before, but they are, however, a very important means of controlling governmental meat inspection, as is shown by the experience of the Grand Duchy of Baden. (Compare page 89.)

General Review of the Traffic of Germany in Living Animals, Fresh and Prepared Meat, Sausages, Lard and Similar Fats in the Year 1897.

Kind of Product	Imports	Exports	Excess of Imports	Excess of Exports
Living Animals—	*Number*	*Number*	*Number*	*Number*
Cows	73,788	2,838	70,950	—
Bulls	5,977	375	5,602	—
Steers	51,282	3,951	47,331	—
Young animals up to 2½ yrs.	71,923	4,966	66,957	—
Calves under 6 weeks	14,597	455	14,142	—
Swine, young pigs excepted	89,826	4,592	85,234	—
Young pigs	2,054	2,298	—	244
Sheep	1,988	199,295	—	197,307
Lambs	431	17,651	—	17,220
(a) Fresh Meat—	*Kg.*	*Kg.*	*Kg.*	*Kg.*
1. Beef	4,449,000	1,119,400	3,329,600	—
2. Pork	11,213,300	75,400	11,137,900	—
3. Mutton	66,500	159,000	—	92,500
4. Other kinds of meat	8,200	11,000	—	2,800
(b) Prepared Meat—				
1. Beef	2,170,500	—	2,170,500	—
2. Pork	4,249,900	92,000	4,157,900	—
3. Ham	3,316,600	1,314,000	2,002,600	—
4. Bacon	17,010,400	139,300	16,871,100	—
5. Other meat	146,300	13,400	132,900	—
6. Sausage	185,900	737,300	1,113,600	—
7. Meat in cans and otherwise hermetically seal'd	3,454,400	88,100	3,336,300	—
Meat extract	1,095,500	71,900	1,023,600	—
Bladders, Intestines, Stomachs	17,179,200	1,719,800	15,459,400	—
Lard and Similar Fats—				
1. Oleomargarine	20,106,100	700	20,105,400	—
2. Lard	97,280,900	43,600	97,237,300	—
3. Tallow	16,669,300	1,204,700	15,464,600	—
4. Animal and refuse fats	5,447,400	7,445,600	—	1,998,200

Frontier abattoirs.—The most satisfactory manner in which we may make use of the meat of our neighboring countries, and all trans-Atlantic countries which are abundantly supplied with animals, consists in the erection of frontier abattoirs. In these the food animals coming from foreign countries are slaughtered, and are thereupon sent in refrigerator cars to the thickly-populated inland districts where food animals are scarce. We possess such abattoirs on the Russian boundary in Myslowitz, Kattowitz, Tarlowitz, Beuthen; on the sea coast, in the abattoirs at Hamburg, Lübeck, Bremen, Kiel, Rostock, Stralsund and Stettin.

The introduction of living food animals through frontier abattoirs makes it possible to subject improper slaughterhouse wares to a careful sanitary police control. Moreover, the introduction of living animals in such slaughterhouses may take place under such regulations that there need be no fear of introducing animal plagues into the country.

Prohibitive Decrees Issued by the German Empire and the Federal States Regarding Imports, According to the Status of the Question on November 1, 1900.*

1. Against Russia the following is prohibited: The importation of cattle, sheep, goats, other ruminants, hogs, all parts of ruminants in a fresh condition, with the exception of butter, milk and cheese; fresh pork and all preparations of pork, pickled meat, salted meat, hams, other smoked products, sausage, meat in brine (with the exception of cooked pork and rendered lard†).

Restricted: The importation of horses, animal parts and products in a thoroughly dried or salted condition.

2. Against Austria-Hungary, a prohibition exists against the importation of sheep and hogs, and the importation of horses, asses, mules, hinnies, cattle‡ and goats is restricted.

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* Annual Report on the Distribution of Animal Plagues in the German Empire for the year 1900. Berlin, 1901.

† The inhabitants of frontier districts are permitted to import pork in quantities of not more than 2 kg. in a raw condition, or in any condition other than cooked, free of duty. In the governmental district of Königsberg, the importation of thoroughly-pickled pork is permitted.

‡ The importation of cattle is restricted to such animals as come from regions free from pleuro-pneumonia, and which are brought to slaughterhouses under veterinary police supervision for immediate slaughter. Moreover, breeding and work animals may be imported in the frontier regions.

3. Against the countries beyond Austria-Hungary (Roumania, Bulgaria, Servia), the importation of cattle, sheep, goats and hogs, fresh meat and other fresh parts of ruminants, fresh meat of hogs, as well as all preparations of pork, with the exception of cooked pork and rendered lard, is prohibited.

4. Against Italy, the importation of cattle, sheep, goats and hogs is prohibited, and the importation of horses, mules and asses is restricted.

5. Against Switzerland, the importation of sheep and hogs is prohibited, and the importation of horses, mules, asses, cattle and goats is restricted.

6. Against France, the importation of cattle,* sheep, goats and hogs is prohibited, and the importation of horses, mules and asses is restricted.

7. Against Luxemburg, the importation of horses, asses, mules, hinnies, ruminants and hogs is restricted.

8. Against Belgium, the importation of cattle, sheep, goats, hogs and all fresh beef is prohibited, and the importation of horses, asses, mules and hinnies is restricted.

9. Against the Netherlands, the importation of cattle, sheep, goats, hogs, and raw animal material in a fresh condition, as well as fresh and recently salted skins from horses and cows, is prohibited; and the importation of horses, asses, mules and hinnies is restricted.

10. Against Denmark, the importation of ruminants and hogs from the boundary line between Schleswig and Jutland†, hogs and fresh pork by land or sea, raw animal materials in a fresh condition by land or sea (with the exception of the transportation through the Empire of fresh and salted pelts and skins), is prohibited, and the importation of horses and ruminants by sea is restricted.

11. Against Sweden and Norway, the importation of ruminants, hogs and fresh pork is prohibited, and the importation of horses is restricted.

12. Against Great Britain and Ireland, the importation of

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* Exceptionally, cattle may be admitted for immediate slaughter in the abattoirs of the frontier localities of Hayingen, Gross-Moyoeuvre Altmünsterol, Saales and Markirch to supply the demand of these communities, and in the fortified towns of Metz and Diedenhofen in the interest of provisioning these localities.

† During the periods from October 1 to December 31, and from April 1 to May 31, of each year, poor animals may be imported into the quarantine station at Hvidding.

ruminants and hogs is prohibited, and the importation of horses is restricted.

13. Against America, the importation of cattle and fresh beef is prohibited, and the importation of horses, goats, sheep and hogs, as well as pork and sausage,* is restricted.

14. Against foreign countries in general, the importation of horses, ruminants and hogs by sea, and of frozen meat from foreign countries, is restricted. (Proclamation of the Governmental District of Königsberg, January 29, 1895.)

* Animal products must be provided with an official certificate stating that the meat was inspected in the export country according to regulations existing in that country, and was found to be free from dangerous properties. (Imperial Decree of September 3, 1891.)

V.

NORMAL APPEARANCE AND DIFFERENTIATION OF MEAT AND ORGANS OF DIFFERENT ANIMALS.

This subject, in the strict and ordinary sense,* includes a study of the normal condition of individual parts, the differential diagnosis of the meat of different animals, and the recognition of the age and sex of slaughtered animals. In addition, the subject includes the utilization of meat and other parts of slaughtered animals. The latter phase of the question will be treated, in so far as seems desirable, as an appendix to the description of the normal condition of the different parts.

1.—Normal Appearance of Different Parts of Food Animals.

(a) The Skin.

In the majority of animals which are slaughtered for meat (beef, calves, sheep, goats and horses), the skin is not used for human food. A knowledge of the normal condition of the skin in these animals possesses, therefore, chiefly a clinical significance (see "Inspection of Animals Before Slaughter"). Only certain parts of the skin of the calf and beef (the head and under parts of the face and lower extremities) are used for human food. In the case of hogs, on the other hand, the whole skin is considered as "meat."

The skin of slaughtered hogs is characterized by its pure white color and elastic consistency. The white color appears more distinctly after scalding. In quite exceptional cases, red spots are observed on the skin of hogs which are not properly bled, and which, consequently, manifest signs of life after being placed in the scalding kettle. In old brood sows the skin possesses a uniform hardness, and in old boars the skin is modified on both sides

* In the broader sense, the pathology of meat belongs also to this subject.

of the breast to a cartilaginous consistency. The cartilaginous parts of the skin of boars is commonly known as the "shield."

The use of the skin of beef animals for sausage.—In former years the heads of young cattle from one to one and one-half years of age were sometimes scalded in the same manner as calves' heads, and used, together with the fleshy parts of the head, in the preparation of schwartenmagen. Recently, however, as stated by Henninger in Lahr, following the example set in the Rhine district, it has become customary in the region of Lahr to scald the whole skin of young cattle and use it for schwartenmagen. This use of the skin is very profitable, since otherwise it brings a much smaller price than the usual fleshy constituents of the above-named sausage. According to the law regulating food materials, it is possible to proceed against dealers in such sausage if this unusual method of preparation is not made known to the purchasers, for skin sausages are an adulterated food material. For other reasons, it would be desirable that skins intended for sausages should be investigated with reference to their nutritive value in the same manner as meat.

"*Head meat*," "*leather meat*."—In Austria, and recently also in Germany (Madgeburg), it has been shown that dealers in skins separate the meat which is found on green skins, especially on the head, and place it upon the market. This traffic should be forbidden, except where the meat is separated immediately after slaughter and before the skin has been soiled; and the skin of condemned animals must be absolutely excluded from use for this purpose.

(b) The Blood.

The normal blood is scarlet red in the arteries, dark red in the veins. In contact with atmospheric air, the venous blood also takes on a light color. The blood possesses the character of a body color; in thin layers it is opaque; the reaction is alkaline. The blood of different animals possesses a specific odor (volatile fatty acids) which becomes more evident on the addition of sulphuric acid. Shed blood is characterized by its property of coagulation. In the heart and larger vessels of dead animals the blood coagulates rapidly, but this does not take place in the capillaries (Virchow).

The blood of hogs and calves constitutes the raw material for the preparation of blood sausage. Beef blood was formerly not used for making sausage, because sausage prepared in that manner

was rough, dull, and crumbled on the cut surface. This defect is now remedied by the addition of milk. The chief use of beef and sheep blood is for the extraction of albumen and the preparation of blood and molasses cake and pepton feed. Where no such profitable use is possible, the blood of cattle and sheep (after coagulation, drying and grinding) is used as a fertilizer. Seheurer, Kestner and others proposed the use of beef blood in the form of blood-bread as a food material for animals, or occasionally for man. In St. Petersburg and Odessa blood-bread bakeries have been established. Blood-bread is prepared from seven parts rye flour and three parts beef blood, and is supposed to serve the purpose of a highly nutritious and cheap food material for poor people. Whether this is really the case appears doubtful, according to the experiments of Colasanti and Sacoangeli. These authors, in harmony with Magendie and Pagen, found that dogs fed on an exclusive blood diet for twenty to thirty days died. This is to be attributed to the fact that defibrinated blood consists exclusively of red blood corpuscles, which are composed of nine-tenths hemoglobin and one-tenth globulin. It is well known that hemoglobin is changed in the stomach into indigestible hematin which is excreted with the feces. The blood of slaughtered animals can not, according to law, be offered for sale as a food material. It is usually rendered impure by contact with the stomach contents which pour out from the severed esophagus during bleeding.

(c) The Most Important Internal Organs.

In the description of the important vital organs, I choose the order in which they are removed from the body of the animal after slaughter. The figures, which are given on the size and weight of the internal organs, are taken from Franck's Anatomy, revised by Martin, and from the special work of Schmaltz on this subject.

The Alimentary Canal.—The covering, smooth and glistening; the walls appearing blue-gray; moveable contents. Absolute absence of contents in the posterior regions of the alimentary tract indicates a closure of the lumen, as in incarceration, invagination, involution and constriction.

The alimentary canal of slaughtered animals is used almost exclusively as casing material for sausage. The alimentary canal of hogs which have been fed acorns is not suitable for this purpose, on account of its liability to rupture.

The serous coat of the large intestine is much sought after as gold beaters' skin and as a basis for animal plasters.

STOMACH.—The stomach is of the same external appearance as the intestines. It is empty only in animals which have fasted. The paunch of ruminants is, however, always full.

The stomach is used partly as a food material, partly as sausage casing, and partly for technical purposes. Thus, beef paunch is used in making tripe; the fourth stomach, as an additional element in making liver sausage; and, in southern Germany, the stomach of the hog is used as a casing for the so-called schwartenmagen. In addition to these uses, pepsin is obtained from the stomach of hogs, and, from the stomach of calves, rennet is obtained for the manufacture of cheese.

Weight of the contents of stomach and intestines.—The weight of the stomach contents is not infrequently the subject of controversy, when animals are sold according to live weight. The buyers presuppose an honest delivery; *i.e.*, there is a tacit understanding that animals which are offered for sale shall receive fodder only up to a certain hour, which varies from 3 to 6 P. M. of the day preceding slaughter. The following figures may serve for deciding differences of opinion which may arise.

According to Wolf, the relation between the weight of the contents of the stomach and intestines, as well as that of the empty stomach and intestines, and the live weight in fasting animals, is as follows:

(A) OXEN.

	Per cent.
(a) *Moderately fat*—	
Contents of stomach and intestines	18.0
Stomach without contents	4.5
Intestines without contents	2.0
Total	24.5
(b) *Half fat*—	
Contents of stomach and intestines	15.0
Stomach without contents	3.0
Intestines without contents	1.5
Total	19.5
(c) *Fat*—	
Contents of stomach and intestines	12.0
Stomach without contents	2.7
Intestines without contents	1.4
Total	16.1

(B) Calves.

Fat—	
Contents of stomach and intestines	7.0
Stomach without contents	1.2
Intestines without contents	2.4
Total	10.6

(C) Hogs

(a) *Moderately well fattened*—	
Contents of stomach and intestines	7.0
Stomach without contents	1.2
Intestines without contents	3.9
Total	12 1
(b) *Fat*—	
Contents of stomach and intestines	5.0
Stomach without contents	0.7
Intestines without contents	2.2
Total	7.9

Hintzen (Zeit. f. Fleisch-u. Milchhyg. III.) found in fasting cows the average proportion of the weight of the stomach and intestines with contents to be 18.2 per cent. (15.5 to 22.7 per cent., the absolute weight varying between 146 and 244 lbs.); in calves, 9.4 per cent. (4.7 to 13.2 per cent., the absolute weight varying from 7 to 26 lbs.); and in hogs, 7.6 per cent. (5.2 to 12.2 per cent., the absolute weight varying from 11.5 to 23 lbs.).

A beef animal may increase in weight from sixty to ninety pounds by one meal.

P. Falk determined the weight of the stomach and intestines in thirty-seven beef animals to be 16.35 per cent. of the live weight (varying from 9.4 to 25.2 per cent.).

According to Dammann, the weight of the stomach contents in heavy hogs, which were fed for the last time between sixteen and twenty hours before slaughter with one to two pounds of barley-grits and clover, amounted to from 350 to 1,600 gm., while in animals coming from some distance, and fed eighteen hours before slaughter, the stomach contents amounted to from three to five pounds or more. In one case (a hog), which was fed eleven hours before slaughter, the stomach contents weighed somewhat more than ten pounds.

Spleen.— This is of different appearance in different animals. The size of the spleen is, however, subject to physiological variations in the same animal. According to Masoin, the spleen attains its greatest volume about five hours after feeding.

In the horse the spleen is flat, sickle-shaped, and, when just removed, of a bluish-violet color, which later becomes reddish-brown; cut surfaces, intensive brownish-red, with scattered white spots; about 45 cm. long and of a flabby consistency; the borders are somewhat rounded; weight, 500 to 750 gm. The weight may increase considerably a short time after the digestion of a meal.

Ox.—Form, an extended oval, flatly compressed; length, 50 cm.; breadth, about 13 cm.; weight, about 1 kg.

Schmaltz found the average weight of the spleen in twenty-eight animals of more than 250 kg., dressed weight, to be 1 kg. (varying from 750 to 1,750 gm.). In thirty-three animals, of from 200 to 250 kg., or less, dressed weight, the spleen weighed, on the other hand, only 0.6 kg., varying between 0.5 and 1 kg.

The color and thickness of the spleen are not the same in male and female beef animals. In bulls and fattened steers, the spleen is of a reddish-brown color, rather firm and thick; both surfaces are convex. In the cow, on the other hand, the spleen has a grayish-blue color, a flabby consistency and flat surfaces. Furthermore, in the spleen of bulls and oxen, the follicles are more apparent and of the size of hemp seed. In bulls and steers the borders of the spleen are moderately rounded; in cows, on the contrary, sharp.

The spleen of calves varies from reddish-brown to bluish-red, and has the same color in both sexes. It possesses moderately convex surfaces and rounded borders, and is of a soft, elastic consistency. The follicles do not appear especially plain.

Sheep and goats.—The spleen has the same form as that of beef animals, is reddish-brown, later becoming dark red in color. The surfaces and borders are rather strongly convex; consistency, soft or slightly elastic; weight, about 60 gm.

Hog.—The spleen is tongue-shaped; in color, a bright red, later becoming dark red, and of a flabby consistency. The follicles appear rather prominent.

Liver.—The liver is also of different form in different domestic animals.

Horse.—Three lobed; the right is the largest; the left, intermediate; and the middle lobe, the smallest. The right lobe suffers, with increasing age, a physiological atrophy (pressure atrophy). The weight of the liver in old horses is from 3 to 4 kg.; in young animals, which have died during the process of stomach digestion, 6 to 8 kg.

Ox.—Form, indistinctly two-lobed. Near the lobus spigelii there is the lobus quadratus (tuberculum papillare). No esophageal notch; no middle sickle-shaped band; gall bladder of a pear shape.

The weight of the ox liver without gall bladder is, on the average, 4.5 kg. (about 1-85th of the body weight). According to Schmaltz, the weight of the liver in cattle of more than 250 kg., dressed weight, averages 5.75 kg. (varying between 4.5 and 8 kg.). In cattle of 250 kg. or less, dressed weight, the liver weight is 4.8 kg., varying between 2.75 and 6 kg. The average weight of the liver in sixty-eight animals was 1-52nd of the dressed weight.

Sheep and goats.—Weight, 375 to 875 gm. (1-53rd of the body weight). On account of these variations in weight, dealers distinguish between large and small sheep livers.

Hogs.—The hog liver has four lobes, besides the spigelian and quadrate lobes and the gall bladder; weight, 1 to 2.45 kg. (1-40th of the body weight). The liver of the hog is distinguished by its large lobuli and the strongly developed interlobular connective tissue. Hog livers are, therefore, easily distinguished from calves' livers in cases of attempted deception.

The following characteristics are common to the livers of all food animals: The bluish-ground color, which later becomes decidedly reddish-brown; the glistening appearance of the parenchyma; the moderately firm consistency—while still retaining the animal heat the liver is considerably softer—and the absence of blood from the numerous larger veins on cross section. The borders of the liver are somewhat sharp. In calves and well-fattened young cattle, from one to four years of age, the liver is thick, the surfaces convex, and the borders slightly rounded. In young cattle, of from one-half to one year of age, and in old cows, the liver is thinner, the surfaces more even, and the borders sharp. In the latter cases, also, the consistency of the liver is flabby and the color a dark reddish-brown.

Variations from the reddish-brown ground color (always apparent in bulls, old steers, poorly fattened sheep, and, in the majority of cases, also in hogs), occur in sucking calves, well-fattened young cattle and steers, as well as in very fat wethers and hogs. In the last-named animals, the liver is yellowish-brown and turbid, and of increased volume (greater thickness and rounded borders). The yellowish-brown color may appear upon the whole liver, as in calves and young steers, or may occur as a band around the periphery of the acini—fatty infiltration of fattened animals. In sucking calves

a so-called transitory fatty infiltration is observed shortly after each sucking.

It is worthy of mention that the weight of the liver is subject to considerable variation, according as the animals are slaughtered during the process of digestion, or after a considerable period of fasting. For the elucidation of this relation I have made several test weighings, and have found differences of as much as 500 gm. in the livers of medium-sized hogs, fasting and fed with clover. Furthermore, the liver of fasting hogs is decidedly reddish-brown in color, while in animals killed during the process of digestion the yellowish color of the liver is never absent.

Lungs.—The lungs do not require such a detailed description as the liver. The most essential characteristics of the normal condition of the lungs are the small blood content and the uniform elastic consistency.

The healthy lungs of bled animals exhibit a rose-red color; the surface is smooth and glistening. On the cut surface, a foamy substance of a light reddish tinge may be rubbed off (residual air). After their removal from the thorax, healthy lungs collapse. Only in cases where the lungs remain for several hours after death in the unopened thorax do they exhibit an incomplete retraction. Butchers, therefore, in localities where inflation is forbidden, allow calves' lungs to remain as long as possible in the thorax in order to give them a more voluminous appearance.

The distinction between the lungs of different domestic animals is of considerable importance, because deceptive substitutions, especially of hog lungs for the more valuable calf lungs, are sometimes made.

The lungs of horses possess a left, anterior and a posterior primary lobe, besides a pyramidal lobe to the right.

The lungs of ruminants are more lobulated; on the left, two to three; on the right, four to five lobes. It should be remarked that the anterior lobe of the right lung of ruminants, in contrast with that of the horse, receives its bronchus independently from the lower end of the trachea.

In the lungs of hogs, two to three lobes may be recognized on the left, and three to four on the right. With the exception that in ruminants the interlobular tissues are more strongly developed, the conditions in the lungs of hogs are similar to those in ruminants.

THE HEART.—The heart of all domesticated animals exhibits a brownish-red color, a smooth glistening covering (the epicardium), and a similar lining within (the endocardium). The consistency of the heart of healthy animals is firm. In the myocardium, on cross section, a conspicuous sheen is observed and an extremely small blood content. In animals which are thoroughly bled, the right and left ventricles contain only a small quantity of coagulated blood. The coronary veins are empty.

The form of the heart is nearly round or conical, according as the heart movement came to a standstill in diastole or systole.

In order to avoid errors, it is necessary to bear in mind that the tissue underneath the epicardium in freshly slaughtered animals is often injected, and this condition should not be confused with hemorrhages (von Hofmann). This reddened condition is always observed at the level of the columnæ carneæ, and never in the intervening depressions. According to Hofmann, this is to be considered a vital phenomenon, which occurs at every systole and disappears again during diastole. The condition indicates, therefore, simply a cessation of heart action during systole. It should also be observed that the injected condition rapidly gives way to redness, caused by imbibition, when the heart is placed in water for the purpose of removing the blood contained in the chambers. True hemorrhagic conditions are frequently found in the cardiac valves of fasting calves as a normal condition (Kläger).

The beef heart is distinguished by the fact that in the fibrous ring of the aorta two cardiac bones are found in the place of a cardiac cartilage. In hogs, the cardiac cartilage may become ossified in old age.

According to Vaerst, a small bone on the right side is formed in sheep in old age; in elk and deer this formation is observed on the right—not on the left; in the calf, up to the fourth week, only cartilage is found. From this time on, however, the formation of the right cardiac bone begins. Lastly, in very old horses, a partial ossification of the cardiac cartilage may occur (Stoos).

KIDNEYS.—The kidneys in most animals are concealed from immediate view by a more or less extensive fatty capsule, known as the kidney-fat capsule. In earlier times this condition was, strangely enough, the chief reason why the kidneys, as a rule, were not studied in meat inspection. The color of the kidneys is reddish-brown; the consistency firm. The surface is smooth and glistening, and discloses numerous red spots (glomeruli), which, on cross-

sectioning the kidneys, appear more conspicuously in the cortical layer. The renal parenchyma shows on the cut surface the same sheen as on the exterior surface.

The right kidney of the horse is heart-shaped; the left is bean-shaped. It possesses a renal papilla. Both kidneys of the horse weigh on an average about 1,500 gm. (1-300 of the body weight). Both kidneys of the beef are oval, but exhibit a lobulated structure. They consist of from fifteen to twenty lobes of different size, and partly grown together. Each lobe (renculus) has a renal papilla, and the two kidneys weigh on an average 952 gm. (about 1-300 of the body weight), but considerable variations occur. The kidneys of steers and bulls, as a rule, are heavier than those of cows.

The kidneys of sheep and goats are bean-shaped, non-lobulated, and have one renal papilla each.

The kidneys of the hog are likewise bean-shaped and non-lobulated, but are characterized by from six to eleven renal papillæ. They weigh on an average 420 gm. (1-150 of the body weight).

Physiological variations from the normal occur in the fattened condition, especially in very fat hogs, more rarely in cattle and sheep. In these animals the color of the kidneys, in consequence of fatty infiltration of the convoluted and straight uriniferous tubules, may become grayish-brown and cloudy. Upon microscopical examination, the epithelial lining of the tubules is found to be densely filled with large, fat globules.

French investigators (Villain and Bascou) have asserted that the color of calves' kidneys undergoes such a typical change that it is possible to make use of it as a valuable aid in the determination of the age of the animals. Villain and Bascou assert that at birth the kidneys are bluish-black; at one week, violet-red, at two weeks, greenish-yellow; and after three weeks, yellowish-red. This change of color, however, is not a regular occurrence.

Pleura and Peritoneum.—These membranes are characterized in their normal state by their smooth, glistening, light-gray and transparent appearance.

If, in slaughtering animals, blood makes its way into the pleural cavity, the pleura takes on a reddish tinge as a necessary consequence. This reddening is to be distinguished from inflammatory reddening by its superficial position, and by the fact that it can be removed by washing. The peritoneum may take on a green and yellow coloring in consequence of injuries to the gall bladder in slaughtering.

THE TONGUE.—In the tongue, the chief points of interest which concern us are the differences of form in the different animals, since on this basis we are in a position to detect substitutions.

The beef tongue is distinguished from the horse tongue by its strong dorsal ridge, its more slender tip, and by its spine-like filiform papillæ, which are covered by a horny sheath, and are inclined backward, as well as by the larger number of circumvallate papillæ (twelve or more on each side, as against two in the horse). Quite often the beef tongue bears black spots.

The tongue of the sheep and goat is hollowed out in the median line at the tip. The filiform papillæ are blunt and not corneous. In dark-colored sheep, the tongue is entirely black or spotted with black; otherwise the conditions are similar to those in cattle.

In hogs, the dorsal ridge is absent; the filiform papillæ are fine and velvet-like, with but two circumvallate papillæ on either side.

The tongue of the dog is flat, without lateral surfaces, but with lateral borders. The filiform papillæ are situated in the anterior two-thirds, are closely crowded together, and the points are directed backwards. The dorsal surface is marked with a median groove. On the posterior surface, in the median line, is found a spindle-shaped body of cartilaginous consistency (the so-called lyssa).

The other internal organs of slaughtered animals require no special discussion. A brief note, however, should be made concerning the secondary sexual organ, the udder. It has sometimes occurred that mammary glands filled with colostrum have been falsely declared to be inflamed or modified by tuberculosis. A careful investigation should protect one against this error.

(d) The Bones.

The most important part of the bones, from the standpoint of sanitary police work, is the bone marrow. A distinction is usually made between red blood-forming marrow and the white, yellow or fat marrow. Red marrow is found in all bones of unborn or newborn animals. In the tubular bones of the extremities, which possess a marrow cavity, the red marrow disappears after birth, and is replaced by a white or yellow, fat marrow. The red marrow remains, however, in all other bones, especially those of the skull, trunk (spinal column, ribs, sternum, pelvis), and in the scapula. Red-bone marrow is of a moderately firm consistency; the fat marrow, on the other hand, has the soft consistency of fat. Neither red nor fat marrow exhibits such a fluid consistency as to flow out

of bones which have been artificially opened. This fact is of importance in the diagnosis of osteomyelitis and osteomalacia. This fluid consistency is not observed even in old animals, in which the fat marrow, as well as adipose tissue in other parts of the body, has partly disappeared and has been replaced by serous, infiltrated tissues.

The total weight of the bones in well-fattened cattle amounts to from 15.1 to 15.4 per cent. of the dressed weight (compare page 192).

(e) The Lymphatic Glands.

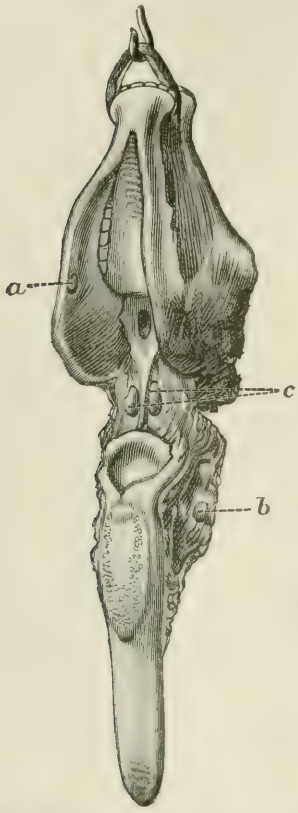
A correct knowledge of the normal condition and position of the lymphatic glands, as well as of the ramifications of the lymph vessels, is of the greatest importance to meat inspectors. The condition of lymphatic glands varies in different regions of the body, and in the same region in the different domesticated animals; especially the size and color vary extremely. It is not strange that such sensitive structures as the lymph glands should be subject to certain fluctuations in size and water content. Considerable changes, or actual swellings, occur only during more intense irritation.

The form of the lymphatic glands is round or oval, the size varying. Some are as small as a pea; others are as large or larger than walnuts. The lymph glands of young animals, still in process of development, are uniformly larger than those of older animals. As a rule, they lie pressed together. The color of the lymph glands is partly white, partly gray and gray-blue. In hogs the white color is predominant. A moderate quantity of fluid pours out on the cut surface of the lymph glands. The consistency is firm, rather than soft. In general, however, the splanchnic lymph glands possess a somewhat softer structure than the lymph glands of the trunk and extremities.

Each lymph gland has a certain region from which it receives lymph through the lymphatic vessels. This relationship of lymph glands is expressed by the term "corresponding," signifying that the glands belong to a certain region. One region, however, may possess several corresponding lymph glands. It should be noted that no lymphatic vessel empties into the thoracic duct or the right lymphatic trunk without passing through at least one lymph gland. Furthermore, all lymphatic vessels of the different organs have their ramifications in the organs themselves. Communications between lymphatic vessels in one and the same region are mani-

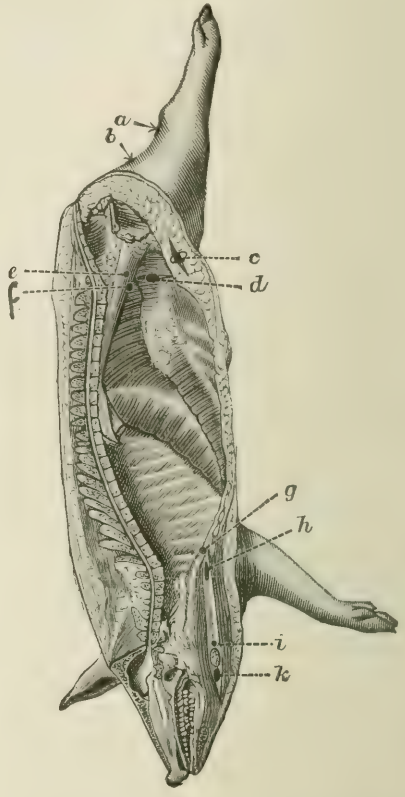
fold. They are absent, however, between the lymphatic vessels of two anatomically separated organs. For instance, a connection between the lymphatic vessels of the alimentary tract and the

Fig. 18.



Beef head. *a*, right, *b*, left submaxillary glands; *c*, retropharyngeal glands.

Fig. 19.



Position of the most important lymphatic glands after removal of the retroperitoneal fat tissue. *a*, lymphatic glands above the hock; *b*, popliteal glands; *c*, superficial inguinal glands; *d*, kneefold glands; *e* and *f*, internal iliac glands; *g*, lymphatic glands of the lower thoracic walls; *h*, lower cervical glands; *i*, upper cervical glands; *k*, submaxillary glands.

spleen does not occur, notwithstanding the widespread erroneous belief to the contrary. The lymphatic trunks, after leaving the corresponding lymphatic glands, pass directly to the thoracic duct without being distributed in any other organ.

The following are the most important groups of lymphatic glands in meat inspection:

(A) Lymphatic Glands of the Head, Trunk and Extremities.

1. The *submaxillary lymphatic glands* (Figs. 18, *a* and *b*; 19, *k*).—These glands, according to Franck, whose description I have followed with reference to the other groups of lymphatic glands, receive all of the lymphatic vessels from the lower half of the head (cheeks, nose, mucous layer of the mouth and tip of the tongue, nasal mucosa and the hard gums). The efferent vessels pass to the upper cervical glands.

2. The *lymphatic glands*, in the region of the parotid gland, posterior to the articulation of the jaw, partly inserted between the lobes of the parotid gland. Lymphatic vessels from the ear, the parotid gland, temporal region, and partly from the base of the skull. Efferent vessels to the upper cervical glands.

3. *Upper or cranial cervical lymphatic glands.*—These glands lie on both sides of the posterior wall of the larynx and pharynx in the region of the thyroid gland (Fig. 19, *i*). A larger and highly important group, from the standpoint of meat inspection, the so-called retro-pharyngeal lymph glands (Fig. 18, *c*), is found in cattle on the posterior wall of the pharynx. Lymphatic vessels from the cranial cavity, base of the skull, pharynx, larynx, diverticulum of the Eustachian tube, as well as the efferent vessels of the lymphatic glands which have already been mentioned.

4. *Middle cervical lymphatic glands*, on the upper third of the trachea.

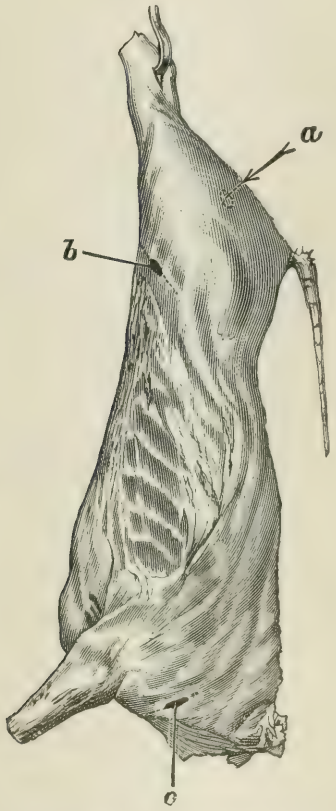
5. *Lower or caudal cervical lymph glands*, lying immediately anterior to the entrance to the thorax on the inferior wall of the trachea (Figs. 19, *h*; 21, *h*). They receive the efferent vessels of the prescapula, as well as of the middle and upper cervical glands; or, in other words, all of the vessels of the neck and head. Efferent duct on the right to the right lymphatic trunk, and on the left to the thoracic duct.

6. *Axillary glands.*—A large cluster of lymph glands covered by the scapula and its musculature (therefore accessible only after removal of the scapula). Lymphatic vessels from the outer thoracic wall and the medial scapula surface.

7. *Prescapular or superficial cervical glands* (Fig. 20, *c*), the location of which must be familiar to all who are acquainted with the subject, since they play a large part in the inspection of tuberculous

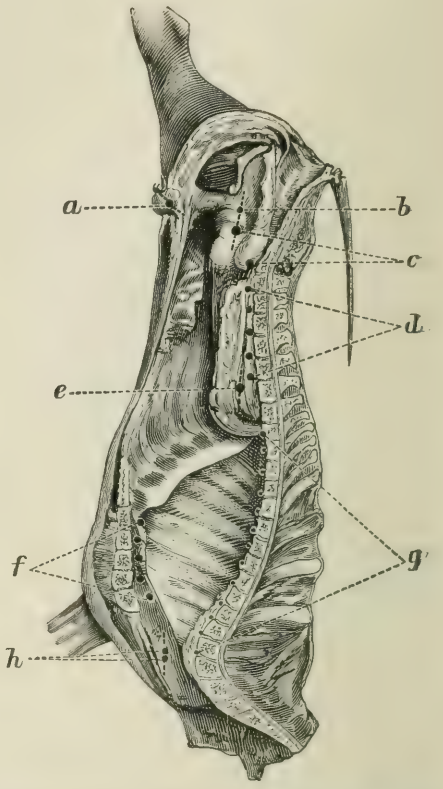
animals. In the horse the prescapular glands form a cluster; in cattle and hogs they are, on the other hand, isolated glands. Position, in front of the shoulder joint, covered by the origin of the

FIG. 20.



Half of beef, seen from the outside. *a*, popliteal glands; *b*, kneefold glands; *c*, prescapular glands.

FIG. 21.



Half of beef, seen from the inside. *a*, superficial inguinal glands; *b*, deep inguinal glands (of variable size and not always present); *c*, internal iliac glands; *d*, lumbar glands; *e*, renal glands; *f*, lymphatic glands of the inferior thoracic wall; *g*, glands of the superior thoracic wall; *h*, lower cervical glands.

brachiocephalic muscle. They receive the lymph vessels from the superficial lymph glands of the neck, shoulder, arm and fore arm.

There may be some difficulty in finding the prescapular glands in very fat hogs. To expose them, it is recommended that a deep, transverse incision be made through the skin from the inferior

border of the neck to the nape, immediately in front of the shoulder joint. The prescapular glands then appear nearly in the middle of the incision (Lohoff).

8. *Precrural or external subiliac glands*, in the cutaneous maximus of the abdominal musculature (Figs. 19, *d*; 20, *b*), at the anterior border of the tensor fasciæ latæ. Lymph vessels from the anterior part of the thigh and from the outer abdominal wall. The efferent vessels pass to the lumbar glands.

In slaughtered hogs, the precrural glands are most easily found if the incision is made into the abdominal wall in front of the femorotibial joint, perpendicularly toward the spinal column (Fig. 19, *d*).

9. *Deep inguinal glands* in the femoral canal, covering the femoral vessels. Afferent vessels from the popliteal glands, from the penis, as well as from the thigh. The efferent vessels pass to the lumbar glands, and in part directly into the thoracic duct.

In the horse, the deep inguinal glands, as stated by Hartenstein, are always easily found; not so, however, in other food animals. According to Rieck, they are not wanting in other animals, but, as a rule, are very small. Their position, according to the statement of Rieck, is at the point at which the external pudic artery arises at right angles from the femoral artery.

10. The *superficial inguinal glands* in the male are placed at the neck of the scrotum, at the side of the penis (Figs. 19, *c*; 21, *a*); in female animals they lie behind and above the udder (supramammary lymph glands). Afferent vessels from the outer external sexual organ, inferior abdominal wall, median femoral surface. Efferent vessels to the deep inguinal glands and immediately into the receptaculum chyli (beginning of the thoracic duct).

11. *Popliteal glands* (Figs. 19, *b*; 20, *a*) lie deep between the inner and outer sacroischiac muscles, immediately above the point of bifurcation of the heads of the gastrocnemius muscle. These glands always become apparent by the dissection of the joint. All of the external lymph vessels of the posterior extremity empty into them. The efferent vessels pass to the deep inguinal and pelvic glands.

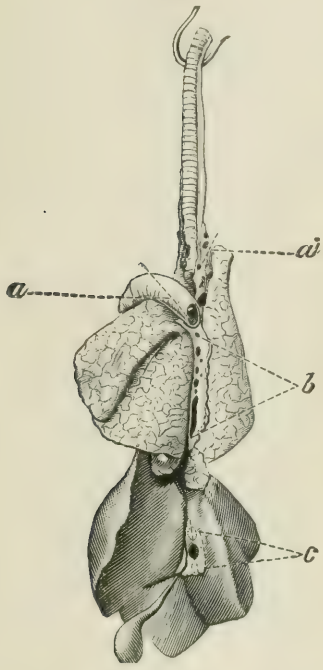
In hogs, besides the popliteal glands, there are other glands varying in size from a pea to a hazel nut, in the panniculus adiposus of this region, but about a hand's breadth above the tuberosity of the calcaneum (Hartenstein). These lymph glands (Fig 19, *a*) are easily discovered only when they are inflamed or tuberculous.

(B) The Lymph Glands of the Thoracic, Abdominal and Pelvic Cavities.

(A) THORACIC CAVITY.

1. The lymph glands of the upper thoracic wall (Fig. 21, *g*), small and numerous; lie partly at the side of the vertebræ, partly in the intercostal spaces. Afferent vessels from the dorsal vertebræ, the exterior muscles of the back, the intercostal muscles, and partly from the peritoneum and diaphragm. Efferent vessels to the thoracic duct.

FIG. 22.



Calf "sling."

a and *a'*, bronchial glands; *b*, anterior and posterior mediastinal glands; *c*, portal glands.

2. Lymph glands of the inferior thoracic wall between the articulations of the costal cartilages near the sternum, small and few in number, following the course of the internal thoracic veins (Fig. 21,*f*). Afferent vessels from the rectus abdominis, the anterior surface of the diaphragm, and from the intercostal muscles.* The efferent vessels pass in part to the anterior mediastinal glands, in part directly into the thoracic duct and the right lymphatic trunk.

3. *Anterior mediastinal glands* (Fig. 22, *b*).—These lie between the folds of the anterior mediastinal membrane. They receive lymph from the heart, pericardium and diaphragm. Efferent vessels into the thoracic duct and right lymphatic trunk.

4. *Posterior mediastinal glands* (Fig. 22, *b*).—Lying under the aortic arch. Receive lymph vessels from the pericardium, the mediastinal membrane, esophagus, pleura, diaphragm, the anterior abdominal region, and from the anterior surface of the liver. Efferent vessels empty in part into the bronchial glands, in part into the anterior mediastinal glands, in part directly into the thoracic duct.

* The intercostal muscles can not be infected by translocation of tuberculous lymph from the pleura. Furthermore, the lymph vessels take their origin in the intercostal muscles, and pass thence toward the pleura or mediastinal spaces.

5. *Bronchial glands* (Figs. 22, *a*, *a'*).—Lying on both sides of the trachea, at its point of bifurcation, are covered by the aorta, and, in fat animals, also by fat tissue. They may be exposed by a deep incision from above and outward to the point of bifurcation. Afferent vessels from the lungs and posterior mediastinal glands. Efferent vessels to the anterior mediastinal glands and thoracic duct.

(B) ABDOMINAL AND PELVIC CAVITIES.

1. *Lumbar glands* (Fig. 21, *d*).—These lie near the lumbar vertebræ, in part covered by the lumbar muscles. Two groups of them,

FIG. 23.

Beef mesentery with tuberculous lymphatic glands.

which lie on either side in the angle between the external iliac artery and the deep, circumflex iliac artery, as well as in the angle of both hypogastric arteries, are especially designated as the internal iliac glands (Figs. 19, *e*, *f*; 21, *c*). Afferent vessels from the pelvic organs, lumbar muscles and upper parts of the abdominal wall; also efferent vessels of the external iliac glands. The vessels of the lumbar glands empty into the thoracic duct.

2. The *external iliac glands* are located near the lateral iliac angle, at the point of bifurcation of the deep, circumflex iliac artery. Afferent vessels come from the lateral and inferior abdominal wall and the lateral surfaces of the femoral region, as well as from the

external subiliac glands. The efferent vessels of the external iliac glands pass to the lumbar glands.

3. The *sacral glands* on the inferior wall of the sacrum, near its lateral borders. Lymph from the superior pelvic wall, and in part from the rectum. Efferent vessels to the lumbar glands.

4. The *ischiatic glands* in ruminants lie on the exterior portion of the ischiatic notch, outside of the pelvic cavity. Afferent vessels chiefly from the popliteal glands, and from the muscles of the sacro-coccygeal region. Efferent vessels empty into the sacral and lumbar glands.

5. The *portal glands of the liver* (Fig. 22, *c*) lie in the porta hepatis, where they are concealed in fattened animals by adipose tissue.

6. The *lymph glands of the spleen* are distinguished by their small size. They lie in the hilus of the spleen, in the gastrosplenic ligament, and, when the spleen is removed, usually remain upon the stomach.

7. The *lymph glands of the kidneys* (Fig. 21, *e*) lie in the hilus.

8. The *mesenteric glands* (Fig. 23) lie between the folds of the mesentery on the concave arch of the intestines, and are in part small and round, and in part larger and somewhat elongated. In ruminants and hogs a very long mesenteric gland is found on the small intestine. Besides this, there is in hogs still another group of small, round lymph glands on the peritoneal attachments of the mesentery.

(f) The Adipose Tissue.

General discussion.—Adipose tissue is not a special tissue, but represents a modification of other tissues (connective tissue, bone marrow, muscle fibers) into adipose tissue. This modification plays a very important rôle in food animals. It is a result which is striven for in fattening, and the degree of its development indicates in most animals (cattle, sheep and hogs) the so-called slaughter maturity. The absence or disappearance of adipose tissue is, under certain conditions, an important criterion for the sanitary decision concerning existing pathological conditions. Adipose tissue develops in the majority of fattened animals, as also in man, especially in certain locations (fat depositories). The fat depositories include the fatty capsule of the kidney, the mesenteries, omentum, subcutaneous, retroperitoneal and intermuscular tissues, liver and bone marrow.

Adipose tissue and fattened condition.—According to the extent and development of adipose tissue, distinction is made between poor, fattening, partly fattened and completely fattened animals.

Poor animals show the presence of fat only in the renal capsules, and between the layers of the mesentery and omentum. In fattening animals, adipose tissue is also found in the subcutis, up to the dorsal surface, from the shoulder girdle to the rump, and in the superior third of the thorax. In bulls there is usually a deposit of fat in the scrotum, and in young cows in front of the udder (so-called fore udder).

In partly fattened animals, a greater quantity of adipose tissue is manifested in superficial area, as well as in thickness, in those parts of the body which have just been mentioned.

In completely fattened animals, the renal capsule is distended with fat, the adipose tissue attaining a thickness of several centimeters. Layers of the mesentery are forced apart by a strong development of adipose tissue which conceals the mesenteric glands from view. Adipose tissue is found under the peritoneal covering of the stomach and alimentary tract. The omentum, like the pericardium, is no longer a thin transparent membrane, but an opaque membrane of considerable thickness. The liver loses its glistening, red-brown appearance, and becomes cloudy in spots or over its entire surface, while an increase in size is perceptible in the whole organ and especially on the borders. The subcutis throughout the body and the upper portion of the extremities is filled with fat. The development of fat is especially noticeable on both sides of the spinal column. The prominent parts of bones are no longer to be seen or felt, while all hollows and depressed areas are filled out with adipose tissue. In the interfibrillar connective tissue of the musculature fat cells are arranged in linear series. Probably these are the cells which furnish the delicate taste of the meat of fattened animals. In the highest grade of fattening, besides being apparent in the locations already mentioned, fat also occurs in the connective tissue under the pulmonary pleura, in the kidneys (convoluted urinary tubules), and even in the muscle fibers in the anatomical condition of fatty metamorphosis.

Concerning histological changes during fattening, Grawitz communicated some very interesting facts. Fattening produces in normal adipose tissue an active cell proliferation. For the fat cell, according to Grawitz, is not simply a large cell, but a "cell colony," consisting of a considerable number of flattened, round, or spindle-shaped cells which become united with the membrane of the growing

fat cell. The bone marrow is likewise transformed during fattening into the status adiposus. "In the muscles, an invasion of fat between the muscle fibers takes place, whereby the muscle fibers disappear; but the fat of red meat is really muscle tissue which has lost its contractility, and, like connective tissue and bone marrow, has become modified into the form and appearance of ordinary adipose tissue." In several different conditions, in which the muscles were not used, Grawitz observed that individual strands of spindle-shaped cells from muscle fibers were disintegrated, and that from these fat cells colonies arose in the same manner as from the cells of connective tissue and bone marrow.

Means of judging the degree of fatness.—In judging the degree of fatness of food animals, butchers habitually feel of certain parts. These manipulations are known as "feeling."

In cattle, butchers preferably test the development of adipose tissue by the "upper feeling" in the ischiac region, the outer angles of the ilium, false ribs, behind the scapular groove on the back, in the orbital groove, and also by the "under feeling" on the shoulder joint, in the kneefold, on the scrotum, on the scrotal raphe in castrated animals, and on the so-called fore udder in cows.

In calves, the butcher investigates the fold between the external ear and the processus mastoideus for the purpose of determining the development of adipose tissue. In older animals attention is given to the scrotum and udder.

In hogs, the trachea, larynx, back, the so-called shield, under surface of the abdomen, external angles of the ilium, and the root of the tail are inspected.

In sheep, the fold between the base of the tail and the ischiatic tuberosity is used in judging the development of adipose tissue.

Anatomy and physiology.—For the peculiarities of fat of various origin, compare the section on the differentiation of meat of different domestic animals. In this connection only the general characteristics of normal adipose tissue will be given. Normally, adipose tissue is opaque, white, or yellow, poor in blood, and of an acinous structure on cross-section. The consistency varies according to the melting point of the different fats, and according to the surrounding temperature. For instance, both beef and mutton tallow harden even in summer. Adipose tissue, which has become pathologically changed, loses its original color, and especially its acinous structure.

The adipose tissue of calves and of old animals shows variations from the normal condition just described. Calves have fat only around the kidneys. The fat of young calves, up to two weeks of age, is characterized by a light grayish-red color. The adipose tissue of fasting calves disappears very readily, and is replaced by a gelatinous tissue. Pure white, hard fat appears in the renal capsules of calves in a fat condition at the age of four to six weeks. Later, after from five to six months, the fat in calves disappears again. In old animals, especially old cows, only the remnants of adipose tissue are found in the locations where fat is ordinarily deposited, and more frequently a serous, infiltrated, yellow, gelatinous connective tissue takes its place.

Influence of feed on fat.—The formation of fat, in the first place, is dependent upon the nutrition of food animals. Liberal quantities of protein, properly balanced with fats and carbohydrates, greatly favor the process of fattening. It is worthy of notice that the formation of fat depends to a great extent upon the method of feeding, provided we overlook certain racial peculiarities; for example, those of Hungarian hogs. The adipose tissue of pasture-fattened cattle is decidedly yellow—so-called yellow feed-coloring. In hogs, also, a slight coloration of the fat is occasionally observed, and is attributed to liberal dieting on maize. Furthermore, it is a well-known fact that in hogs the firmness of the adipose tissue varies according to the kind of feed which the animals receive. Milk, potatoes and barley produce the best bacon. It is thick, firm, marbled and palatable. Maize can be used for fattening hogs without any injurious effects. As soon, however, as the animals attain the weight of 120 pounds, feeding with maize should cease, because, otherwise, the bacon becomes soft (results of Danish investigations). A defect in the taste of bacon is noticed in hogs which have been fed oats and beans to excess; in the first, a slightly oily, and in the second, a slightly bitter taste, is noticeable. The fat of hogs which have been fattened on beech nuts acquires an oily character and a slight taste of beech nuts. In fattening with rice-meal, or distillery refuse of corn, the bacon becomes soft, is easily separated, and of a disagreeable taste. Hogs raised on swill develop a very bad quality of bacon. It is soft, oleaceous, and of a flat, disagreeable taste. Swill contains a large quantity of rancid fat. Hogs which are fed with herring or smelt develop a rank-smelling, gray-colored adipose tissue which hardens but slightly. The same modifications may occur in the meat of cows fed on herring cakes. According to all

experience, it is the excess of a particular kind of fat in the feed which exercises the above described injurious influence upon the quality of adipose tissue.

The experiments of Lebedeff are in agreement with this statement. This author allowed a dog to fast for a month, or until it had completely lost all its body fat, and then fed it for three weeks on meat, which was almost free from fat, and linseed oil. From the tissues of the dog more than 1 kg. of a volatile, fatty oil was obtained which did not become hard at a temperature of 0° C. In its chemical properties it closely resembled linseed oil. From the musculature and adipose tissue of another dog, which had been fed on mutton tallow, Lebedeff succeeded in obtaining a fat which was almost identical with mutton tallow. Lehmann demonstrated that even from the feeding of small quantities of fat a partial deposition of the food fat took place without change, provided a certain kind of fat was fed for several months. Lehmann fed two hogs from July 10 to February 3 on the same basal ration, the second hog receiving in addition a quantity of olive oil not exceeding the fat content of a normal feeding stuff, such as corn. In all, hog No. 2 received 15.36 kg. olive oil, together with 394.6 kg. barley, 18.4 kg. meat meal and 12.8 kg. clover. While the iodin number of the fat of hog No. 1 varied in different parts of the body between 52.9 and 58, the iodin number of hog No. 2 varied from 58.1 to 62.5. From these results Lehmann computed that in all 7.37 kg. of olive oil, the iodin number of which was 82.65, passed over into the fat of hog No. 2.

Commercial significance of fat in slaughtered animals.—Fat animals bring better prices than poor ones for two reasons: First, because of a better, closer relation between the dressed weight* and live weight than in poor animals, and, secondly, because the meat of fat animals possesses a better flavor than that of poor animals.

Thus, in cattle, the difference between the live and dressed weight varies, according to the condition of the animal, between 40 and 65 per cent.; in fat and poor sheep, between 45 and 65 per cent.; and in fattened and fattening hogs, between 15 and 25 per cent.

Thus, Lawes and Gilbert found that, on an average, the dressed weight constituted the following percentages of the live weight: Fat steers, 59.8; fat calves, 63.1; poor sheep, 53.4; very fat sheep, 64; fat hogs, 82.6.

* By dressed weight in cattle is understood the weight of the four quarters. From the live weight there is subtracted the weight of the blood, skin, head, feet and entrails, with the exception of the kidneys. (Compare page 190.)

Hengst calculated the average dressed weight, from statistics obtained in the cattle yards of Leipsic during a period of three years (1889-1891), as follows: Steers, 53.4; heifers, 55.9; cows, 48.4; bulls, 54.3. In the year 1898: Steers, 53.6; heifers, 51.3; cows, 50.8: calves, 69; sheep, 53; hogs, 86.5 per cent.

In weighings of eighty-eight well-fattened cattle, made by the German Agricultural Society in the army meat conserve factories at Mainz and Haselhorst, the highest dressed weight was 63.3 per cent. of the live weight. Incidentally, the animal which showed this high dressed weight was affected with generalized tuberculosis.

In the meat markets of Berlin, it is customary to deduct 20 per cent. of the live weight, where hogs are sold according to dressed weight.

Average Absolute Dressed Weights.

By taking the average of dressed weights during the three years, 1889–1891, Hengst determined the following absolute dressed weights:

	Kilograms.
Steers	365
Bulls	354.1
Cows	276.3
Heifers	263.6
Calves	38.8
Sheep	27.6
Hogs	88.8

In 1898:

8,984 steers	379.10
915 heifers	251.38
6,868 cows	284.13
2,227 bulls	374.58
511 calves	42.06
2,528 sheep	28.43
14,991 hogs	90.72

The average live weight in Leipsic in 1898 was:

983 steers	705.04
104 heifers	489.52
485 cows	559.42
530 bulls	645.78
786 calves	61.35
481 sheep	53.88
490 hogs	104.56

Kleinschmidt, in Erfurt, calculates dressed weight as follows:

Steers and bulls	350
Cows and cattle	275
Calves	28
Sheep and goats	25
Hogs	85
Horses	200

	Kilograms
Goltz, in Halle, as follows :	
Steers and bulls	404
Cows and heifers	310
Calves	33
Sheep and goats	28
Hogs	115
Horses	305
Rieck, in Zwickau, as follows :	
Steers	336.9
Heifers	294.7
Cows	311.4
Bulls	375.5
Farm hogs	89.9
Bacon hogs	98.9
Calves	34.8
Sheep	26.4
Ruser, in Kiel, as follows :	
Cattle	240
Calves	35
Sheep	21
Hogs	85
Horses	230

Rules for the determination of dressed weight.—For a simple means of estimating the value of animals at slaughterhouses, the conference of delegates of German Slaughterhouses and representatives of the German Agricultural Commission, as well as representatives of meat and cattle dealers, in session in Berlin, November 6th and 7th, 1895, decided, essentially in accordance with the suggestions of Hengst, to establish, as a basis, a dressed weight estimated according to fixed principles.

The calculations of the dressed weight shall be made in the following manner :

SEC. 1. Before the calculation of the weight, the following parts of animals are to be excluded :

I.—In cattle :

(a) The skin, but in such a manner that no meat or fat remains upon it. The tail is to be removed, but the so-called caudal fat must not be taken away.

(b) The head, between the occipital bone and the first cervical vertebra, perpendicularly to the vertebral column.

(c) The feet. In the first (lower joint of the carpus and tarsus), above the so-called shin bone.

(d) The organs of the thorax, abdomen and pelvis, with the attached fat masses (heart fat and mediastinal fat), with the exception of the kidneys and surrounding fat, which must be included in the weight.

(e) The blood vessels along the spinal column and in the interior portion of the thoracic cavity, together with the attached tissues, as well as the trachea and the tendinous portion of the diaphragm.

(f) The spinal cord.

(g) Penis and testicles, excepting, however, the so-called scrotal fat in bulls; the udder and fore udder in dry cows, and cows pregnant beyond the half term.

II.—In calves:

(a) The skin, together with the feet, in the lower joint of the carpus and tarsus.

(b) The head, between the occipital bone and the first cervical vertebra.

(c) The organs of the thoracic, abdominal and pelvic cavities, with the exception of the kidneys.

(d) The navel and the external sexual organs of bull calves.

III.—In sheep:

(a) The pelt, together with the feet, in the lower joint of the carpus and tarsus.

(b) The head, between the occipital bone and the first cervical vertebra.

(c) The organs of the thoracic, abdominal and pelvic cavities, with the exception of the kidneys.

(d) The external sexual organs of bucks and wethers, and the udder of ewes.

IV.—In hogs:

(a) The organs of the thoracic, abdominal and pelvic cavities, together with the tongue, trachea and esophagus; with the exception, however, of the kidneys and peritoneal fat.

(b) The external sexual organs of boars.

SEC. 2. The calculation of the weight shall be as a whole, in halves, or in quarters in cattle; as a whole in calves and sheep, and as a whole, or in halves, in hogs.

SEC. 3. If the determination of the dressed weight is made in cattle inside of twelve hours, and in other animals within three hours after slaughter, one pound (½ kg.) is to be subtracted from every 50 kg. as so-called warm weight.

SEC. 4. For every determination of dressed weight, a weight certificate is to be given on request, upon which the words "Dressed weight" shall be written.

Market quotations for food animals.—The Ministries of Agriculture, Public Domains, Forests, Commerce, Manufactures and Interior, of the Kingdom of Prussia, under date of July 9, 1900, issued a general decree concerning the quotation of prices for food animals in the larger meat markets for the purpose of rendering the prices uniform. The quotations must be made from dressed weight or live weight, according to local custom. If both forms are in use, a separate quotation must be made for each. The desirability of quotation according to the live weight is doubted, since the dressed weight, corresponding to the actual value of the animal, varies considerably, even in the same stage of fattening: (in well-fattened hogs, for example, between 77.7 and 90.2 per cent.). Furthermore, the live weight is very differently affected by transportation, and the quality of the meat can not be judged in the living animals.

Nutritive value of the meat of fat and poor animals.—According to a large number of chemical analyses (see König, "Chemische Zusam-

mensetzung der menschlichen Nahrungs-und Genussmittel"), the meat of fat animals is distinguished by a smaller water content in comparison with the meat of poor animals. As maintained by Schmidt-Mülheim, however, the decrease in water content is not conditioned by a decrease of the muscle water which would correspond to an increase of the muscle protein, but chiefly through the deposition of fat. The relative protein content of meat is lessened by the increase in fat, as appears from the following statement of König. The figures were obtained as averages of a large number of analyses :

1. Meat of very fat steers : Water, 53.05 ; protein, 16.75 ; fat, 29.28.

2. Meat of moderately fat steers : Water, 72.03 ; protein, 20.96 ; fat, 5.31.

3. Meat of poor steers : Water, 76.37 ; protein, 20.71 ; fat, 1.74.

Fat meat is consequently poor in protein, and, therefore, really of less food value than poor meat ; for fat, especially the fat of cattle, is much cheaper than protein. This fact, however, is without influence upon the market value of meat. The meat of fat animals is preferred because it possesses more tender fibers, and, as stated, a more agreeable taste than that of poor animals. The most valuable meat, however, is that of moderately fat animals, since it combines a good taste with a high protein content.

(g) The Skeletal Musculature.

General discussion.—The skeletal musculature is the most important part of the body of food animals. It furnishes the meat of commerce, and with it the fat tissues, which inclose and penetrate the muscles, the nerves which are connected with the muscles, vessels, lymphatic glands and bones are included.

According to Lawes and Gilbert, the proportion of pure muscle meat is found to be 45.5 per cent. in a fat calf ; 47.9 in a half-fattened steer ; 40.2 in a fat steer ; 36.9 in a fat lamb ; 37.5 in a poor sheep ; 38.4 in a half-fattened sheep ; 29.8 in a fat sheep ; 47.6 in a poor hog, and 37.3 in a fat hog. The remainder is to be reckoned as skin, entrails, fat and bones. The bones constitute a considerable portion of the body weight, a larger proportion in poor than in fattened animals. In poor cattle, for example, they constitute one-eighth of the weight ; in fat cattle, on the other hand, only one-fourteenth.

Concerning the weight of the individual parts of well-fattened cattle, careful investigations were made by the German Agricultural

Society in the army conserve factories at Mainz and Haselhorst, near Spandau. These studies were made from eighty-three animals selected from different races, and the following results were obtained. A racial difference in the dressed weight was found only in certain unimportant points. This was particularly true of the skin. Highland breeds have a somewhat heavier skin than lowland German cattle. The average weight of the skin in the former was 48.3 kg., or 12.7 per cent. of the dressed weight; in the latter, 46.4 kg., or 11.1 per cent. It also appeared that lowland cattle had a higher percentage of intestinal fat, kidney fat and tallow than highland breeds (intestinal fat in lowland cattle, 9.6; in highland breeds, 7.02; kidney fat and tallow, 6.95 and 5.2 per cent., respectively). It appears, however, that this difference is due less to racial peculiarities than to the method of fattening and the different ages of the animals. The differences with reference to the bones are quite insignificant (mountain animals, 15.4; lowland, 15 1 per cent.). In the first observations, the striking fact appeared that the fore quarters were heavier than the hind quarters, while in slaughter tests, which took place during the fat-animal exhibit in Berlin, the hind quarters were uniformly considerably heavier than the fore quarters. This is probably explained by the fact that the cattle in Berlin were in better condition and showed a larger quantity of kidney fat. Heretofore, opinions have been much divided on the question whether the hind quarters or fore quarters had the greater weight of bones. This question was, therefore, considered, and in one of the animals which was studied, and in which the two quarters weighed exactly the same, 194 kg., it was found that the loin roast weighed 17.75 kg.; the fillet, 9.75; the remainder of the meat, 270; the waste in meat and fat tissue, 9.30; kidney fat, 25; the bones of both fore quarters, 31.80; and the bones of both hind quarters, 24.50 kg.

In meat furnished to troops, there may be present the following weights of bone after cooking: In 100 kg. of raw beef, not more than 11 kg.; in 100 kg. of raw mutton, not more than 13 kg.; in 100 kg. of raw pork, not more than 9 kg.; in 100 kg. of raw veal, not more than 18 kg.; and in 100 kg. of lean rib bacon, not more than 2 kg.

"Meat" and animal materials in a raw state.—In a broader sense, the entrails are also considered as meat. The Reichsgericht, in a decision of November 4, 1889, held that under the term, "meat in general," the stomach, intestines, and all parts of food animals

which are in any way used as food in commerce should be included, while the term, "raw animal materials," should be understood to mean only such substances of animal origin as are worked over for industrial or technical purposes, but which are not used for food.

Histology.—The histological components of skeletal musculature are the striated muscle fibers, which consist of sarcolemma and the contractile contents, and also the inter and intramuscular connective tissue. In the contractile content of the muscle fiber highly characteristic phenomena are observed after death, which distinctly separate muscle tissue in its physical and chemical relations from the other tissues of the animal body.

Physical characters of striated musculature.—The muscles of freshly slaughtered animals exhibit active contractions. The color is dark-red (hemoglobin). There are, however, pale muscles.* The consistency is firm, but yielding. Fresh muscles, which are still capable of reacting, are characterized by a glistening appearance.

This condition does not persist very long. After a short time certain groups of muscles, the head and neck muscles, become stiff (muscle rigor). Other muscles follow these, until finally the whole musculature and the joints become inflexible, stiff and firm (*rigor mortis*). At the same time, the muscles become turbid and opaque. All these phenomena are produced by the coagulation of the myosin, in consequence of the formation of lactic acid in the muscles. The coagulation of the myosin causes what was not observable before, namely, the appearance of muscle serum on sections of the muscles.

The beginning and duration of *rigor mortis* are subject to considerable variations. Very strong muscle contraction before death (for example, in cases of tetanus, strychnine poisoning, etc.) causes a rapid and intensive rigor (Landois). Wild animals, hunted to death, pass into *rigor mortis* within a few minutes. Among drugs, veratrin, alcohol, ether and the etherial oils favor the early appearance of *rigor mortis*. In general, the time for the appearance of *rigor mortis* varies from ten to fifteen minutes to several hours

* Pale muscles are well developed in mammals, especially in the rabbit and hog. The calf has white meat up to the sixth month. In grown cattle, the skin (superficial) muscles are partly pale. Furthermore, pale muscles are often found in connection with red muscles in fish and birds. The fibers of pale muscles, according to Ranvier, are thinner and more closely striated; but the longitudinal striations are less distinct than in red muscle fibers. According to Grützner, there are pale fibers in nearly every muscle.

after death. Du Bois-Reymond demonstrated that boiled muscles do not pass into *rigor mortis*. This is to a certain extent the case in hydremic cachexia; also in septicemia and swine erysipelas (Hertwig).

Rigor mortis persists for from one to several days. As a rule, the rigor passes off first in those animals in which it appeared earliest. Muscles in rigor become softened again in consequence of an increased formation of acids which dissolve the myosin.

With reference to *rigor mortis* in fish, Ewart stated that it appears earlier and more intensively in muscles which were more vigorous and capable of stimulation. Furthermore, a close connection is demonstrated between the cessation of rigor and the beginning of decomposition. If the contents of the intestines be removed and disinfectants applied, the condition of rigor may be maintained for almost any period. In cases where the brain and spinal cord are removed after death, the rigor persists considerably longer than in animals which are not thus mutilated.

Of special interest is the power of muscles retaining the animal heat, and not in rigor to "fix" large quantities of water. This peculiarity is especially noticeable if pieces of muscle are previously pounded or torn into shreds. In this manner meat which is intended for use in the manufacture of sausages may be artificially increased by 70 per cent. of its weight of water.

The influence of feeding on the physical properties of meat.—Butchers generally complain that the firm character of meat, especially in hogs, is becoming more and more rare on account of the extensive use of the by-products of manufacture in fattening. The best results, with regard to the condition of the meat, are obtained when hogs are fed with milk, barley and potatoes. Favorable results are also obtained when maize is substituted for barley.* The use of peas and other legumes in the place of barley is undesirable, since the meat takes on a bitter taste when legumes are used as the exclusive grain feed. Feeding clover is not to be recommended, for the reason that the meat becomes soft and of a loose texture. Very undesirable effects are obtained from the use of rice-meal. The meat becomes soft, spongy and of a disagreeable odor, and can scarcely be used for sausages (on account of its loose texture and paleness), or for pick-

* In America, as well as in Hungary, maize is used almost exclusively in feeding hogs. The animals become heavier (fatter) than on a barley diet. The quality of the meat, however, is undoubtedly better when the hogs are fed on barley.

ling (on account of its oleaginous character). The same effects are produced by feeding distillery refuse of corn, and animal meal.

Chemical peculiarities of striated musculature.—According to König the meat of poor steer beef, with a fat content of 1.74 per cent., contains about 20.71 protein and 76.37 per cent. water. For muscle meat with a fat content of 1 per cent., Voit gives as an average 20 per cent. of proteids and gelatinous substances, together with 75.8 per cent. of water. Besides proteids and fat, there are other important constituents of muscle meat, namely, the extractives, creatin, creatinin, sarcin, zanthin, and muscle salts. Among the latter, sarcophosphoric acid (Siegfried) plays an important part. This acid in neutral, slightly acid, or alkaline solution, holds phosphoric acid in a fixed condition and, therefore, makes possible the simultaneous transfer of phosphoric acid, lime, and magnesium into the fluids of the body. According to Siegfried, one of the most important actions of meat broth and meat extracts depends upon this fact.

The potassium and sodium content of meat vary in different species of animals. The largest quantity of potash salts, with which the content in phosphate varies in a parallel manner, is found in fowls, 4.65 per cent., and the smallest in the eel, 2.41. Among food animals, pork is especially poor in potash salts, but rich in sodium salts.

According to Landois, with the extractives belong osmazon, which gives meat its characteristic agreeable taste. The odor of meat depends on volatile fatty acids and differs with each species of animals. (Compare "Differentiation of Meat of Different Food Animals.")

The reaction of the musculature during life is neutral, but becomes acid (sarcolactic acid and volatile fatty acids) soon after death, according to Edelmann and Noack, within three to six hours. In animals slaughtered for sanitary reasons, the acid reaction may appear after two or three days, or later, or may entirely fail to appear, so that the musculature may remain neutral even to the time of the beginning of decomposition (Edelmann and Noack). The presence of acid causes the beginning of *rigor mortis*. The increase of acid content, however, brings about a cessation of this condition (the myosin is soluble in 0.5 per cent. lactic acid). Under the influence of putrefactive bacteria, the acid reaction of the musculature gradually becomes alkaline (presence of ammonia).

According to Stinzing, carbonic acid constitutes from 15 to 18 per cent. of the volume of the musculature; oxygen is not present in muscles (Hermann).

Rigor mortis, or the appearance of sarcolactic acid in the musculature, is of great culinary importance. Meat prepared for cooking immediately after slaughter is unsavory and so tough that it can be masticated only with the greatest difficulty. Meat in rigor, however, with an acid reaction, is tender and of good flavor, since comparatively low temperatures (60° to 70° C.), in connection with the action of lactic acid, are sufficient to transform the interfibrillar connective tissue into gelatine. The texture of the meat becomes loose and the individual fibres are readily separated in the stomach (Landois).

Toughness of meat.—Lehmann demonstrated that the variation in the toughness of raw meat depends upon the difference in its content of collagen. In the apparatus used by Lehmann in his experiments, a weight of 1,040 gm. was required for biting off collagenous connective tissue (tendon); while for elastic tissue (ligamentum nuchæ) a weight of only 580 gm. was required. Collagenous tissue, however, loses almost all of its firmness by cooking, while elastic tissue remains entirely unchanged. Therefore, meat which is rich in connective tissue becomes softer in cooking, while meat which is poor in connective tissue is not so affected. Thus, for biting through a fillet of beef before cooking, a weight of 83.4 gm. was required, and after cooking a weight of 84 gm., while for biting through dermal muscle of cattle, a weight of 236.4 gm. was required before cooking and 88 8 after cooking.

Lehmann also made the interesting discovery that meat while hanging loses about 25 per cent. of its toughness through an acid fermentation in the course of a few days.

Fitness of meat for the table.—True fitness of meat for fastidious palates is obtained by allowing it to remain in an ice chest or cold storage for two or three weeks. In this way, under the influence of sarcolactic acid, the meat becomes unusually tender and somewhat friable, without being exposed to the danger of decomposition. Similar results are obtained by placing meat in vinegar or sour milk.

Under all circumstances decomposition during the ripening of meat for the table is to be avoided. Decomposing meat is not only disagreeable, but also an unhealthful food material. We must, therefore, characterize as very unappetizing and dangerous the fad

of certain gourmands who, mistaking the nature of real "hautgout," regard decomposition as a necessary condition for palatable meat.

"*Hautgout.*"—According to W. Eber, genuine hautgout is not a decomposition, but a sort of acid fermentation which, possibly in connection with hydrogen sulphid, leads to the formation of a desired flavor. The acid fermentation finds favorable conditions in the meat of game from the fact that this meat, in spite of its high blood content, decomposes much less readily than the meat of domestic food animals.

Of great importance for meat inspection is the reducing power which the musculature as well as other animal tissues possess. The experiments of Hermann, Ehrlich, Grützner, and Gscheidlen, Hoppe-Seyler, and Eber have demonstrated the existence of a reducing property in the animal cell and the surrounding fluid. This is especially the case in the musculature. The reducing power of animal tissue is manifested in intoxications (transformation of poisonous into harmless substances during life), and in slight and serious cases of icterus (gradual transformation of bilirubin into colorless compounds through the living tissue (Eber).

Meat as a nutrient medium for bacteria.—Finally, it should be remembered that muscle meat, in consequence of its chemical composition, offers not only a very suitable nutrient medium for putrefactive bacteria, but also for pathogenic micro-organisms. This property plays an important rôle in the post mortem intensification of the toxicity of the meat of diseased animals, as well as in the infection of meat through contact with diseased meat or through incidental carriers of contagion. Bocklart demonstrated that about thirty species of the bacteria with which he experimented developed very luxuriantly on meat.

2.—Differentation of the Meat of Various Food Animals.

The expert is frequently called upon to give an opinion of the species of animal from which a given piece of meat or meat product originated, for the substitution of cheap meat for the more expensive kinds frequently occurs. Thus, horse meat is sold for beef, goat meat for mutton, mutton for venison, dog meat for pork, cat meat for hare. Furthermore, it may happen that the less valuable buffalo meat may be marketed as beef and colt meat as veal.

Such substitutions are to be considered as violations of Section 263 of the Statutes of Germany (Deception, see page 116). In this connection it is not the nutritive value of the substituted meat, but simply its market value which determines the matter. (Prussian Chamber of Justice, Decision V, 1810-1886.) The most frequent deception is the addition of horse meat to sausages.

As a means of preventing the substitution of horse meat for beef, all regulations for meat inspection prescribe that horse meat shall be offered for sale only in certain market booths which are properly designated. In the same manner, it is required that authority be secured for a declaration of buffalo, goat, and dog meat for sale.

For the differentiation of the meat of the various domestic animals, the following points should be considered:

(a) Color, consistency, and odor of the meat and its content of adipose tissue.

(b) Color and consistency of the adipose tissue.

(c) The structure of such bones as are present.

For the identification of horse meat, we may, furthermore, find valuable assistance in the demonstration of glycogen (Niebel), in the determination of the iodin number of the fat (Hasterlik), and of the fatty acids (Bremer), as well as in the determination of the refraction number of the fat (Nussberger).

(a) Color, Consistency, Odor and Fat Content of the Meat of Different Food Animals.

Horses.—Horse meat in general has a dark-red color, which takes on a bluish sheen on the surface after lying for a long time. Klein called attention to the fact that horse meat darkens so rapidly in the air that its color, after a short time, appears to be almost black. Baranski noted the appearance of fasciæ in horse meat. Furthermore, it is said that in cooking, and on the addition of sulphuric acid, a decided odor of the horse stable is developed (specific volatile, fatty acids). According to Baranski, the specific horse odor is given off from horse kidneys in every method of preparation for use. In cooking horse meat, moreover, the yellow oil globules which appear on the meat juice are conspicuous.

Zündel, in his day, mentioned that, after treatment of samples of meat with sulphuric acid, the specific odor of the animal species was developed so plainly that the origin of the meat could be determined with certainty from this fact alone. Leisering, however, was

unable to substantiate this assertion by experiment. In one case, when Zündel's test was applied, buck meat was determined as pork. According to Puntigam and Halusa, however, the test with sulphuric acid is applicable in differentiating between buffalo meat and beef. If samples of beef and buffalo meat are cooked in water strongly acidified with sulphuric acid, the odor of meat broth appears in the beef, while, in the buffalo meat, a stronger, disagreeable odor, recalling that of cattle dung, becomes noticeable.

CATTLE.—The color of beef varies according to the age in which the cattle are killed, and also according to sex. Young cattle, of six to fifteen months of age, have a light-red meat, with little fat, of fine flavor, and of rather firm, elastic consistency. Bulls, one and one-half to four years of age (they are not commonly kept as bulls to a greater age), are characterized by their dark-red, tough, coarse-grained muscle tissue, which is poor in fat. Steers, one and one-half to six years of age, possess a light-red meat of moderately firm consistency, which becomes a brick-red when hung up, and which is strongly interlarded with fat (marbled). Older yoke oxen, on the other hand, which are fattened shortly before slaughter, possess darker, firmer and tougher meat than young steers. Furthermore, the meat is not interlarded with fat, but the fat is deposited for the most part under the skin, in the omentum and mesenteries, as well as in the region of the kidneys. The meat of fattened heifers and young cows is only slightly different from that of young steers. On the other hand, in older cows which have been milked one finds a lighter and firmer meat. Fat tissue in old cows is, as a rule, present in small quantities. In cases where it is exceptionally well developed, it is deposited in the same locations as in old steers.

A faint, not disagreeable, specific odor is noticed in fresh beef. According to Baranski, the meat of cows is often tinted with a faint odor of milk or cow dung.

In a fresh condition, buffalo meat is darker and more reddish-brown than beef. After cooling, it exhibits a pale-red color resembling that of young beef, and possesses a violet sheen on the freshly cut surfaces. Furthermore, buffalo meat has a coarse grain. Its broad and flat muscle fibers are held in contact by a loose connective tissue. The strictly muscular part of the superficial shoulder muscles in the buffalo forms a strip not wider than four fingers, while in cattle it is much wider. There is also always a striking musk-like odor in buffalo meat, which appears in cooking. In the

cooked condition, buffalo meat is tough, and less easily cut than torn (Puntigam and Halusa).

Calf.—Veal is characterized by a light, pale red color, a fine but rather tough fiber. The meat of calves fattened on milk is conspicuously pale or pure white. The consistency varies according to age and degree of fatness. The odor is specific, and differs from that of beef. If veal is allowed to hang for a long time in the skin, as is customary for protection against drying, the meat takes on an acid odor (active formation of sarcolactic acid). The fat content of the muscles is minimal.

The meat of immature calves—that is, those which are killed during the first week of life—is of a lighter color than that of older calves of a higher water content, and of a softer consistency. The muscles, especially those of the hind quarters, are still only slightly developed, and the finger easily penetrates them. *Rigor mortis* is very inconspicuous. The adipose tissue, which is present, posessses a jelly-like consistency. The so-called double-loin calves, which are characterized by the enormous width of the chest, with an unusually voluminous development of the ischiac and femoral musculature (double loins), possess little fat and a dry, dark flesh (see Kaiser, Land. Jahrbücher). In the older double-loins, the meat appears almost "as black as in an old bull."

Sheep.—The meat of sheep has a light-red or brick-red color, fine fiber, and moderately firm consistency. In well-fed animals an abundance of fat is found between individual muscles, especially, however, under the skin and in the fatty capsule of the kidneys. Older breeding animals have a dark-red and firmer meat, with comparatively little fat. The odor of the meat of sheep is specific, comparable frequently with that of the rumen of those animals, often also with that of the sheep barn. The meat of bucks sometimes possesses the so-called buck odor.

Goats.—The meat of goats varies according to age, and is of a lighter or darker red color. The scarcity of fat under the skin and the disagreeable goat odor are characteristic. Goats become, according to popular terminology, "secretly fat"; that is, they possess a strongly developed fat capsule around the kidneys, in spite of the absence of the panniculus adiposus. The peculiar sticky character of the subcutis of goats brings it about that, in skinning these animals, hairs become attached to the meat, and serve as a certain

means of detecting the origin of the meat. Goat meat, as has already been mentioned, is, like horse meat, to be declared as such on the market.

Goltz suggests the following as a criterion for distinguishing between the meat of goats and sheep. Goats are far less disposed to form deposits of fat than sheep. Furthermore, little fat is found under the skin of the thorax and abdomen in well-fed goats as compared with well-fed sheep, while the kidney capsule, even in poor goats, is surrounded by a thick layer of fat. The meat of young goats is light in color; the dermal muscles of older goats are, however, of a darker red than those of sheep.

Mutton, when killed at not too great an age, possesses a sweet, slightly ammoniacal odor, which can be easily recognized by holding the nose close to the meat. In the meat of female goats the buck odor exists to but a slight degree, or not at all.

Hogs.—The meat of fattened hogs is pale-red and rose color, in part white (pale muscles); strongly infiltrated and surrounded with fat; fibers fine; consistency soft; odor not definable. Old breeding animals, boars and sows, possess a dark-red, firm meat, poor in fat. In such hogs the subcutis is most frequently free from fat. In older boars a thickening and induration takes place in that portion of the skin in connection with the subcutaneous tissue which lies over the thoracic region (formation of the so-called shield). In castrated animals and in cryptorchids, in which the testicles are not atrophied, a highly repulsive urinous boar odor is to be noticed in the meat in a fresh condition and during cooking.

In cooking, pork becomes white; the meat of other animals, gray (disintegration of hemoglobin, which takes place at 60°–70° C.).

(b) Color and Consistency of Adipose Tissue.

The consistency of fat tissue, and of the fat content in the tissue, is dependent upon its content of stearin and olein. A high stearin content gives fat a firm consistency and a high melting point. The character of the fat depends on the species of animal, and is also influenced by the kind of food material chiefly used. For this reason, the figures which are presented possess a qualified reliability.

Horse.—The fat of the horse is light golden-yellow (subcutaneous fat and kidney fat) or brownish-yellow (mesenteric fat), soft and oleaceous (a high content of olein). It begins to melt at a

temperature of 30° C. Rendered horse grease is white, and begins to melt at 32° C. (96 per cent. olein). The fat of the bone marrow is waxy yellow; hardens in the air, and takes on a greenish sheen. It melts at 65° C. In fattened and so-called mine horses, the whole adipose tissue may become of a pure white color.

CATTLE.—The adipose tissue of young, fattened cattle is distinguished by its white color and rather firm consistency after setting. Beef tallow sets very quickly, and is always solid at ordinary temperatures. It contains approximately one part of liquid to three parts of solid fat, and melts, according to Schulze and Reinecke, at from 41–50° C. A yellow color is observed in the fat of young cattle when fattened exclusively on grass; also in old animals, especially in old cows. In the latter the consistency of the fat becomes softer at the same time. Beef tallow may be recognized by a slight, peculiar, but unmistakable odor.

Calf fat is at first reddish yellow-white, but later becomes pure white. It is much softer than beef fat.

The fat tissue of the buffalo is of a striking white color, possesses a musk-like odor, and, when rubbed between the fingers, feels dry and somewhat sticky. The fingers do not become oily in rubbing, however, as is the case in beef tallow. The kidney fat in the buffalo is usually but little developed, has a dull color, and shrinks very quickly on cooling (Puntigam and Halusa).

SHEEP.—The sheep possesses a beautiful white fat, with a melting point at from 31°–52° C. (content of solid fat variable; on an average about 70 per cent.). Mutton fat is almost completely odorless.

GOAT.—Goat fat is similar in character to that of sheep.

HOGS.—The fat tissue is white; exceptionally, it is yellow (in corn-fed animals), or gray (fattened on fish). The consistency varies according to the food material (page 187), and according to the race of hogs. The Chinese and Hungarian fat hogs (so-called Bakony, Szalonta and Mangalicza hogs) possess an oily fat which sets with difficulty, while the pure English hogs and improved breeds of native hogs possess a firmer fat; that of the latter breeds melts at from 42.50°–48° C. (62 per cent. liquid fat).

DOG.—Dog fat is characterized by its white color, oily consistency, and a pronounced specific odor. It melts at 22.5° C.

It is only in the natural state, and before rendering, that the peculiarities of fat offer really practical means for the determination of its origin. In the rendered condition, the color and melting point may be changed at will by mixture with the fat of other animals.*

In conclusion, it should be noted that the varying consistency of fat in cattle, sheep, hogs and horses is dependent upon the part of the body in which it is deposited. Thus, for example, the scrotal fat of oxen melts at 43.5°; kidney fat, on the other hand, at 50° C.

According to analyses by Schulze and Reinecke, the subcutaneous fat possesses regularly a lower melting point than that of the mesenteries, omentum and renal capsules. Thus, for example, the melting point of fat in a well-fattened Southdown-Merino wether was found to be 44.5° in the panniculus adiposus; 48.5° in the mesentery; 49° in the omentum; 51.5° in the kidneys; in a well-fattened ox, 41° in the panniculus, 48° in the omentum, and 50° in the kidney fat. Similar differences were observed in the hog: panniculus, 46.5°; kidneys, 47°; intestines, 48°.

(c) Character of the Skeleton.

Concerning the differential characters of the bony skeleton of the different animals which come up for consideration in substitutions, we have the comprehensive work of Martin (Zeit. f. Fleisch-u. Milchhyg., I), as well as Sussdorf's Lehrbuch der Anatomie, which gives especial attention to these points. For details, reference is here made to these works. From the first-named work we select the following essential points with reference to the more important bones.

Horses and Cattle.—In the first cervical vertebra of cattle the posterior foramen alarium is wanting; cervical vertebræ, 3 to 7, inclusive, are easily recognized in cattle by their shortness. The spinous processes of the anterior dorsal vertebræ of the horse are short in comparison with those of cattle, and are furnished with strongly developed summits. The spinous processes of the lumbar vertebræ of cattle stand perpendicularly, and are separated from one another; in the horse they are directed forward, and almost touch one another. The transverse processes of the lumbar vertebræ in cattle are directed forward, and are never connected as the posterior

* On the identification of rendered fat by the help of the iodin and refraction numbers, see page 219.

ones are in the horse. The sacrum in cattle is more decidedly arched than in the horse. The coccygeal vertebræ are shorter than those of cattle, and in cattle the spinal canal is closed in the first five; in the horse, only in the first three. In cattle the ribs are flatter and broader in the middle and lower third than in the horse. In cattle the sternum is broad and flattened, while in the horse the anterior portion is keel-shaped. The scapula in cattle is decidedly triangular, the neck being thinner than in the horse. The humerus in cattle possesses two trochanters, in contrast with three in the horse. The external tuberosity, which is strong in the horse, forms merely a ridge in cattle. The radius in cattle is shorter and straighter than in the horse. The ulna in cattle is a distinct bone, while in the horse the body has almost entirely disappeared. The pelvis in cattle is narrower and longer in its posterior portion than in the horse. Furthermore, the ischiac tuberosity has three prominences, while in the horse it has two. The neck of the femur in cattle is more constricted than in the horse. The trochanter major in cattle has grown together with the middle trochanter, while the trochanter minor is entirely wanting. In cattle, the head of the fibula is present as a small hook process on the tibia. In the horse, on the contrary, it is separate from the condyle. The trochlea of the astragalus stands straight in cattle; in the horse it is turned obliquely outward.

The bones of the buffalo are smaller and more easily broken than those of cattle. The tubular bones are shorter, their compact substance being thin and very brittle; the ribs are considerably broader and less curved than those of cattle. Consequently, the intercostal spaces appear strikingly narrow. On cross-section of the lower part of the ribs, the lateral costal surfaces in cattle appear biconcave, while in the buffalo they are more parallel to one another. While in cattle the lower surface of the ischiopubic symphysis is convex, and the upper surface correspondingly concave, so that on cross-section it has the form of an arch, the upper and lower surface in the buffalo are plane, and the cross-section of corresponding form. The superior flat portion of the ilium is considerably broader, the exterior iliac spines are strongly directed outward, and, therefore, the pelvis appears to be much broader. The body of the ilium in the buffalo cow is much more strongly curved than in the domestic cow. The entrance to the pelvis, therefore, has more nearly the form of a circle, while in the cow it is elliptical and comparatively narrow.

Sheep and Goats.—According to Martin, the bones of goats are distinguished from those of sheep by their slender form. Furthermore, in the goat the majority of the processes are longer and with sharper angles than in sheep. In the goat, the first eight spinous processes of the dorsal vertebræ are bent backward rather decidedly. In the goat the twelfth vertebra is the diaphragmatic vertebra, and in sheep, the eleventh. The scapula in sheep is short as compared with its width; the border of the spina scapulæ is slightly curved backward into an arch in its middle, while in the goat it is straight. The pelvis in sheep is more compressed than that of goats.

With reference to the difference between the skeletons of sheep and goats, attention should also be called to the careful work of Bützler ("Contribution to Comparative Osteology of Sheep and Goat." Inaug. Diss.: Leipsic, 1896), in which attention is called to the fact that the lachrymal fossæ, which are characteristic of sheep, are entirely wanting in the goat. The atlas in the goat is longer and narrower than in the sheep, the anterior tubercle being higher and more pronounced. Similarly, the alæ are considerably longer than in sheep. The axis is narrower and more slender, and its spinal ridge is developed anteriorly and posteriorly over the bodies of the vertebræ. The vertebrarterial foramen is wanting; on the other hand, the intervertebral foramen is one-half larger than in sheep. The spinous processes of the remaining cervical vertebræ are long, pointed and provided with sharp edges in the goat; while in sheep, on the other hand, they are broad and blunt. The transverse processes of the cervical vertebræ of goats are thin and delicate. Similarly, the dorsal vertebræ of the goat are narrower than those of the sheep. Furthermore, the lumbar vertebræ possess a considerably longer and more slender form than in sheep. The spinous processes form a thickened, cushion-like ridge on the upper end. The number of sacral vertebræ in the goat is at least four, never three, as sometimes happens in the sheep. Furthermore, the lateral borders of the ankylosed sacral vertebræ are thin and sharp, while in the sheep they are thickened like a cushion. The lower surface of the sternum in the goat is concave, while in the sheep it is flat and even. All of the pelvic bones of the goat are considerably slenderer and thinner. The pelvis itself is narrow and long; consequently the pelvic opening is much narrower than in the sheep. Important differences are also observed in the scapula: that of the sheep is broad and short; the spine is strongly developed, and bears a cushion-like thickening in the middle, which is directed backward in the form of a bow. In the goat the spine is flat, straight and

considerably lower. The neck of the scapula is well developed. The bones of the extremities of goats, with the exception of the metacarpus and metatarsus, which are shorter than in the sheep, are slenderer and thinner. The muscle processes and articular processes are slenderer and less strongly developed. The posterior surface of the fibula is concave. The tibia is decidedly twisted in a spiral manner.

A general comparison of the skeletons of both these species of animal shows that the bones of the goat are characterized by a slenderer form and smaller joints. In contrast with these conditions, the bones of the sheep are shorter, more compact and massive, and the articular connections are larger.

Lohoff draws attention to the fact that the bones of the goat are harder and more brittle than those of the sheep, and that the former break like glass.

Sheep, Goats and Deer.—Martin asserts that it is easier to distinguish between deer, sheep and goats than between sheep and goats. Especially in the comparison with sheep, the deer is at once distinguished by its graceful, slender bones. The cervical vertebræ of the deer, in proportion to their thickness, are even longer than in the goat; the spinous processes of the dorsal vertebræ, from the third to the twelfth, are bent forward. On the lumbar vertebræ in deer, the spinous processes are drawn out into a sharp hook, pointing forward. This structure is decidedly smaller in sheep and goats. The angle of the spine of the scapula in the deer is prolonged downward into a sharp point, which is either wanting in sheep and goats, or is much less strongly developed. The radius, ulna and humerus of the deer are characterized by their slender form. The radio-ulnar arch in sheep and goats is an oval space; in the deer, it is very long. The pelvis of the deer is small, very narrow, and its posterior portion is very long. In the deer, the body of the femur, in proportion to its extremities, is much slenderer than in the sheep and goat.

Hog and Dog.—On a careful examination, these animals present many differences in the skeleton. The first cervical vertebra in the hog possesses on its upper surface a prominent tuberosity, which is flattened in the dog. The second, as well as the third, cervical vertebræ in the hog are short as compared with those of the dog. The dorsal ridge of the second vertebra in the hog is drawn out into a process directed backward, while in the dog this process is

directed forward. The odontoid process in the hog is short and blunt, while in the dog it is long and pointed. The third cervical vertebra of the hog possesses a long spinous process, which in the dog is only a slight ridge. The dorsal vertebræ of the hog are distinguished by their enormous blade-like spinous processes. In the dog they are much smaller, rougher and thicker. Furthermore, the vertebral bodies in the hog are relatively broader than in the dog. In the lumbar vertebræ it is to be noted that the spinous processes, with the exception of the last one, become broader above, while in the dog all of them become narrower; the spinous processes in the hog stand almost perpendicularly to the vertebral bodies, while in the dog they are directed forward and downward. The sacrum of the hog consists of four ankylosed vertebræ; that of the dog, of three. The spinous processes in the hog are rudimentary and bifurcated, while in the dog they are ankylosed into a sharp ridge. The ribs of the dog are more strongly curved and rounder than those of the hog. The sternum of the hog is flat and broad posteriorly, while that of the dog is long and narrow. It is to be noted that the neck of the scapula in the hog is considerably longer than in the dog. Furthermore, the spina scapulæ is directed backward in the hog in the middle third of its length; in the dog, in its inferior third. The humerus of the hog is distinguished by its extraordinarily strong lateral muscle prominences, as well as by its hook-shaped lateral trochanter, which is bent inwardly. Furthermore, both condyles in the dog run in a nearly parallel direction, while in the hog the lateral condyle is curved in a slightly spiral manner outwardly. The fore arm of the hog is shorter, and bent forward more decidedly than in the dog. The elbow of the hog is characterized by its length and strong development. The pelvis of the dog is distinguished from the very long hog pelvis by its shortness. The ischium of the dog is short and broad, while in the hog it is greatly elongated. The femur of the dog is stronger than that of the hog. The tibia in the dog is slenderer than in the hog, and slightly bent in the form of an S. The fibula in the hog is distinguished by its stronger development, and by a groove-like fossa on its exterior surface.

Hare and Cat.—On the first cervical vertebra of the hare, the wings project further laterally than in the cat. The dorsal ridge of the axis in the cat is drawn out into a hook-shaped process posteriorly and blunt in front. In the hare these conditions are exactly reversed. The dorsal vertebræ of the hare exhibit spinous processes

which are directed forward, while the spinous processes in the cat, on the other hand, as far as the twelfth vertebra, are slightly curved in a backward direction. Martin calls attention to the striking differences in the lumbar vertebræ. In the hare it is observed that the large transverse processes, which are directed forwards, are prolonged into anterior and posterior lobes. In the cat the narrow transverse processes end in a point. Furthermore, in the hare the ventral ridge of the vertebral body is prolonged into a sharp spine, which is wanting in the cat. The ribs of the hare are broad and flat; those of the cat more nearly round. The scapula of the hare is distinguished by the fact that the angle of the spine is prolonged into a long point which is bent backwards at right angles. The lower end of the humerus in the cat is almost twice as wide as in the hare. The fossa olecrani in the hare forms a broad opening, while in the cat it is not broken through. The pelvis of the hare is stronger than that of the cat. In the hare there is a strong trochanter minor below the trochanter major of the femur, while the trochanter minor is wanting in the cat. The tibia of the hare is longer, and the spiral twist is less strongly developed than in the cat.

Hare and Rabbit.—Martin found differences between the hare and rabbit in the dorsal vertebræ, the spinous processes of the rabbit all being bent slightly backwards. The hook-shaped, anteriorly-projecting protuberances are also wanting. In the middle lumbar vertebræ, the backward-directed accessory processes are considerably longer, not spinous, as they are in the cat, but lobed. The ventral spine, or hook-shaped point, is similar to that of the hare. The ends of the transverse processes, however, are not so plainly bilobed in the rabbit as in the hare. The spinous processes of the sacrum are ankylosed into a ridge. The lateral portions are more sharply marked off from the wings. The ribs are similar to those of the hare, and the same may be said of the scapula, humerus and radius. The ulna, on the contrary, is relatively stronger, especially in the lower third. Furthermore, in the cat the olecranon process is bent more decidedly forward, so that the posterior border of the bone forms a more sinuous line than in the hare. Martin was unable to establish any essential differences in the pelvis, femur and tibia.

The Differentiation of Horse Meat and Beef According to Niebel.

The differentiation of horse meat from beef possesses the greatest practical significance, since the substitution of the former for the latter is very frequent. For this reason, meat inspectors for a long time sought to secure reliable criteria for the demonstration of horse meat. The peculiarities of horse meat already described are not sufficient to furnish proof regularly, or even in the majority of cases, for those bones which alone can furnish reliable distinctions are removed before the meat is offered for sale. The demonstration of horse meat in sausage has hitherto been absolutely impossible, because other meat, and especially other fats (hog fat), have commonly been added to the sausage. It was thought possible to discover peculiarities in the fibers of horse meat through microscopic inspection. Some authors believed they had found an important criterion in the crystals of hemin. The investigations which were undertaken in this direction were, however, without result. Limpricht claimed to have demonstrated dextrin in large quantities in horse meat. This demonstration, however, was not confirmed by subsequent investigation. More noteworthy is the discovery of Niebel, that through the demonstration of glycogen we are in a position to recognize horse meat even in mixtures, sausages, etc. Niebel observed the peculiar sticky character of horse meat, and was at first inclined to refer it to the dextrin content. Dextrin, however, was found to be wholly wanting; but Niebel found large quantities of glycogen in horse meat, and from his investigations drew the following conclusions: "That in horse meat, as compared with other kinds of meat, glycogen is found in large quantities; in such quantities, in fact, that, without reference to the age of the meat, the smallest amounts found in horse meat exceed the greatest amounts found in other kinds of meat."

The conditions of the occurrence of glycogen in the meat of various food animals are illustrated in the following table, the quality of the meat at the time of the examination being good in all cases:

Kind of Meat	*Age of Meat*	*Per cent. Glycogen content*
Horse	3 hours	0.700
Horse	3 hours	1.026
Horse	1 day	.373
Horse	2 days	.603

Kind of Meat	*Age of Meat*	*Per cent. Glycogen content*
Horse	3 days	.523
Horse	4 days	.524
Horse	5 days	1.072
Horse	5 days	.460
Beef	4 hours	.204
Beef	1 day	.000
Beef	2 days	.000
Beef	½ hour	trace
Beef	5 days	.076
Pork	4 hours	.000
Pork	2 days	.000
Mutton	—	.000

For the demonstration of glycogen, Niebel made use of the Külz method. The meat to be studied (50 grams), together with from 3 to 4 per cent. of caustic potash and four times its volume of water, is heated on a water bath for from six to eight hours, until it is completely disintegrated. After the fluid has been evaporated to half its volume, and then cooled, the nitrogenous substances are precipitated by the alternate addition of hydrochloric acid and mercuric iodid—iodid of potash solution (Brücke's reagent). Then the precipitate is placed in a filter, and the filtrate is again tested by the addition of hydrochloric acid and mercuric iodid—iodid of potash solution—to determine whether all the nitrogenous constituents have been precipitated. The residue is rubbed up in a mortar to which hydrochloric acid, mercuric iodid—iodid of potash solution—and water are added, and again filtered. This operation is repeated until the filtrate shows no cloudiness on the addition of alcohol. The filtrate then forms ordinarily a clear fluid which is opalescent in the presence of glycogen. At times, especially in summer, the fluid appears to be somewhat cloudy. In order to avoid this, if the fluid does not become clear after the addition of hydrochloric acid and mercuric iodid—iodid of potash solution—sodium hydrate is added until the mixture is still of a faint acid reaction, and then again acidified with hydrochloric acid and filtered. The filtrate is then always clear.

For the separation of glycogen, the filtrate is diluted with two and one-half times its volume of 90 per cent. alcohol, and the mixture stirred. After the glycogen is separated it is filtered. The glycogen is then washed with 60 per cent. alcohol, then with 90 per cent., and finally with absolute alcohol, ether, and again with absolute alcohol, and, after drying at a temperature of 110° C., is weighed.

Glycogen exhibits the following characters: It is an amorphous white powder, which with water forms a decidedly white, opalescent solution, and, with the addition of iodin, gives a Burgundy-red color. Fehling's solution, however, is not reduced by it.

Niebel also demonstrated that the glycogen in horse meat possesses an extraordinary resistance, probably because horse meat withstands decomposition longer than other kinds of meat. In individual horses it is observed that, according to the nutritive condition, previous exercise and health of the animals, considerable fluctuations occur. Well-fed horses at rest show a higher content of glycogen than poorly fed, overworked or feverish animals. Overworked or feverish horses are not admitted for slaughter. In poorly nourished horses the amount of glycogen always considerably exceeds that of other food animals.

After a time a portion of the glycogen in horse meat passes over, first, into a dextrin-like substance, then into maltose, and finally into grape sugar. For this reason, Niebel attempted to determine the quantity of sugar in old meat. This was accomplished, according to a special method, by means of Fehling's solution. In this connection, however, it should be remembered that, in addition to grape sugar, meat contains other reducing substances; for example, creatinin. This substance is formed in different domestic animals in the same manner and in the same quantity from creatin. Niebel found also that horse meat, especially when not quite fresh, contains much reducing substance in addition to glycogen, while the meat of other animals slaughtered for human consumption is poor in glycogen and sugar. The total sugar content is determined by computing glycogen as grape sugar (162 parts of glycogen = 180 parts grape sugar).

According to Niebel, the identification of horse meat may be considered as certain when the quantity of carbohydrates obtained (computed as grape sugar) exceeds the highest content of carbohydrates thus far found in other kinds of meat; viz., about 1 per cent. of the dry, fat-free substance.

It is noteworthy that pickling, roasting and smoking destroy neither the glycogen nor the sugar of horse meat; nor, on the other hand, does it increase the sugar content of beef, at least not to such an extent that it exceeds the maximum content of about 1 per cent.

The identification of glycogen, and determination of the sugar content, can also be relied upon for the demonstration of horse meat in sausage. Niebel found no glycogen in sausages which were made of beef and pork. Grape sugar was found in these sausages only in

the proportion of 0.7 per cent. of the dry, fat-free substance. The addition of cane sugar to sausage, which is customary in Berlin, did not interfere with this process. In horse-meat sausage, the total quantity of carbohydrates exceeded the maximum content of these materials in ordinary sausage eleven-fold. With this statement, as Niebel says, public opinion is in entire accord, since it is commonly stated that horse-meat sausage is distinguished by its sweet taste.

It is scarcely necessary to call attention to the fact that minute quantities of horse meat added to sausage can not be demonstrated by Niebel's excellent method. This consideration, however, does not in the least impair the great value of the method just described.

Since, furthermore, the meat of fetuses and fasting calves possesses a high glycogen content, it is well to note the color of the sausage in determining the question whether horse meat is contained in it. Sausage made of horse meat is dark-brown. On the other hand, sausage to which the meat of fetuses or veal is added in large quantities is light-gray. Moreover, the addition of the meat of fetuses or fasted veal to sausages (bratwurst) is a deception, or at least an adulteration.

Trotter tested the method of Niebel, and found in horse meat two days after slaughter from 1.4 to 1.85 per cent. of glycogen; after four days, 1.45 per cent.; after eight days, 1.375 per cent., and after ten days, 0.9 per cent. In six samples of beef and in one sample of mutton, glycogen was not present. Of two samples of pork, one had no glycogen, and the other 0.26 per cent.

Bujard obtained from fresh horse meat from 0.174 to 1.366 per cent. of glycogen (= 0.64 to 4.62 per cent. of the dry substance); in smoked horse meat, 0.108 (= 0.19) per cent.; in horse-meat sausage, from 0.034 to 1.762 (= 0.05 to 5.34) per cent. The high glycogen content was found in leberwurst; the low, in fresh salami sausage. In old salami sausage, only mere traces of glycogen could be demonstrated. Beef gave from 0.018 to 0.206 per cent. of glycogen (= 0.073 to 0.74 per cent. of the dry substance). Veal gave from 0.066 to 0.346 (= 0.25 to 1.44) per cent., and pork gave either no glycogen or a mere trace.

According to Kemmerich, South American beef extract contains a relatively large amount of glycogen—on an average from 1 to 1.5 per cent. Kemmerich ascribes this previously unknown occurrence of glycogen to the fact that South American beef is worked up in such a fresh condition that decomposition of the glycogen is impossible.

In connection with Czerny, Ruppert demonstrated that glycogen constantly occurs in small quantities in blood and pus. The blood of dogs and sucking calves, according to the determinations of Ruppert, contains a much larger amount of glycogen (1.56 and 1.33 mg., respectively, in 100 gm. of blood) than that of herbivorous animals (cattle, 0.77; horses, .38 to .72 mg.). In cases of continued suppuration and persistent acute dyspnea, an increase in the glycogen content of the blood occurs up to 7.33 mg. in 100 gm. of blood. The glycogen content of blood, however, never reaches the percentage which Niebel demonstrated in the musculature of the horse.

(a) Modification of Niebel's Method, According to Bräutigam and Edelmann.

For the determination of glycogen, Bräutigam and Edelmann recommended the iodin reaction described by Claude Bernard, giving attention to the following method:

1. A small quantity (50 gm.) of the meat to be studied is minced as finely as possible, boiled for one hour with four times its volume of water, and the meat broth thus obtained treated in the manner described in Secs. 4 and 5 following. If the reaction therein described does not appear at all, or is doubtful, then

2. Caustic potash (3 per cent. of the volume of the meat), dissolved in the same quantity of water, is added, and the whole is heated upon a water bath until the muscle fibers are entirely disintegrated.

3. The meat decoction thus obtained is allowed to cool, evaporated to a weight double that of the meat originally used, and filtered.

4. The solution thus obtained, after completely cooling, is carefully diluted with nitric acid, for the purpose of separating the majority of proteid bodies and to decolorize it, and again filtered.

5. This filtrate (the meat broth obtained according to Sec. 1, and likewise acidified with dilute nitric acid and filtered) is treated with iodin water, which must be prepared hot and completely saturated. The iodin water is carefully poured upon the filtrate in the test tube, whereupon, at the point of contact of both fluids in the presence of horse meat, a Burgundy-red or violet ring is immediately formed, the extent, strength and intensity of which depend upon the quantity of horse meat present in the sample under investigation, or upon the richness of the latter in glycogen.

This color reaction must certainly and unquestionably be present. The investigation, therefore, should be undertaken only in daylight. Before carrying out the iodin reaction, the material which is being studied must be tested for the presence of starch-flour (dilution of a decoction with tincture of iodin or Lugol's solution). If starch is present, the method is to be modified in the following manner:

1. The sample to be studied, together with a suitable quantity of water, is heated in a porcelain vessel on a water bath for several hours for the purpose of extracting any glycogen which may be present.*

2. The filtered extract should then undergo evaporation on the water bath to one-third of the weight of the meat used in the test.

3. To this evaporated extract, which, according to circumstances, contains much amylogen, concentrated acetic acid is added in double or treble its volume; whereupon, after a half hour, flocculi appear in the cloudy fluid, which mass together more and more, and finally sink to the bottom as a starch precipitate. As a rule, the fluid, after most careful filtration through a double filter, is free from starch. One can become convinced of this fact by adding iodin to a small portion of the fluid; otherwise one should make a further addition of acetic acid and wait a short time.

4. The fluid thus freed from starch can at once be treated with iodin water. Hereupon, a glycogen reaction always appears if the quantity of horse meat in the material under investigation is not exceedingly small. Glycogen can, of course, be extracted from this material, but its demonstration, in the excessive dilution which the fluid has undergone through the addition of acetic acid, can not be brought about with certainty by means of a simple film of iodin water upon the fluid. For this reason, Bräutigam and Edelmann do not conclude their method in such cases with the addition of iodin water, but usually prefer a precipitation of the presumptive glycogen. For this purpose,

5. The starch-free extract is diluted with from ten to twelve times its volume of alcohol, and the cloudy fluid is filtered through a very closely woven, small filter. The latter holds any traces of glycogen which may be present, and which

6. Is to be dissolved in a few drops of hot water, slightly

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* According to Bräutigam and Edelmann, special importance is to be placed upon the thickening of the aqueous extraction on the water bath, for, in cooking over a flame, a part of the starch-flour may be transformed into dextrin, which gives a reaction similar to that of glycogen.

acidified with acetic acid. These few drops of glycogen solution are best caught in a flat porcelain vessel, and a few drops of iodin water are allowed to run down from the edge of the vessel to the fluid. At the point of contact of the reagent with the fluid, the characteristic and unmistakable red color appears at once in the presence of the smallest quantities of glycogen.

The preparation and testing of fluids containing starch must follow in close succession, and must not, under any circumstances, extend over several days; for Bräutigam and Edelmann observed that in solutions containing amylogen, when exposed to the air, erythrodextrin is formed through the influence of ferments, micro-organisms, etc. This substance may give rise to false conclusions on account of its red-color reaction with iodin. The separation of dextrin from glycogen has thus far never been accomplished.

With materials which, presumably, contain only small quantities of glycogen, Bräutigam and Edelmann prefer boiling for several hours in water, rather than with caustic potash, for the reason that the latter substance may have the effect of decomposing the glycogen.

The qualitative determination of glycogen by means of the iodin reaction, as recommended by Bräutigam and Edelmann, and as tested with reference to its applicability to meat and meat preparations, puts us in position to make a rapid inspection of suspected meat, and to decide whether or not the more accurate quantitative determination, according to Niebel, is required in any particular case.

The qualitative demonstration of glycogen is not sufficient to allow us to assume the presence of horse meat with the certainty necessary for legal purposes. For, as Niebel has shown, beef may also contain glycogen under certain circumstances. The quantitative determination of glycogen excludes the possibility of such an objection, since it leaves no doubt as to whether or not the quantity of glycogen peculiar to horse meat is present.*

(b) Modification of Niebel's Method, According to Courtoy and Coremans.

Courtoy and Coremans consider the precipitation of albumen as indispensable, and proceed in the following manner:

* In his latest work (Zeit. f. Fleisch-u. Milchhyg., V), Niebel considers the demonstration of horse meat in sausage as complete when the material in question is colored brown-red, and permits the demonstration of glycogen according to the method described on p. 211.

1. Fifty grams of the meat to be studied in a fresh condition, and, after mincing finely, is boiled with 200 grams of water for fifteen minutes. Meat preparations should be boiled for thirty minutes.

2. After the meat decoction is completely cooled, it should be filtered through paper which was previously moistened, in order to keep back any fat bodies which might be contained in the emulsion. In case of fluids which contain starch and are thick, it is best to use a fine linen filter.

3. To a small quantity of the filtrate in a test tube should be added a few drops of a fluid containing two parts of iodin, four of iodid of potash, and 100 of water. Three reactions may take place:

(a) No dark-brown coloration of the filtrate appears, in which case no horse meat is present.

(b) The fluid assumes a dark-brown color, which disappears on heating to a temperature of 80° C., and reappears on cooling. This indicates horse meat.

(c) An intensive blue coloration of the preparation appears, which discloses the presence of starch and obscures the glycogen reaction. In this case, the starch is precipitated by the addition of from two to three times the quantity of concentrated acetic acid, and the filtered fluid is treated again with the iodin-potassic iodid solution for the purpose of securing another reaction.

According to their method of investigation, Courtoy and Coremans were unable to demonstrate in the meat of cattle, calves, hogs, dogs, cats and rabbits the reaction which is to be observed in the case of horse meat, or any similar reaction. On the other hand, the meat of the fetuses of horses, cattle, sheep and rabbits gave the same reaction as horse meat. The same investigators observed, furthermore, that the internal and external masticatory muscles of the horse, strange to say, do not give the glycogen reaction of the other muscles of this animal. Edelmann rightly observed, with reference to the method of Courtoy and Coremans, that the unstable nature of starch, and the similar behavior of its modification products to that of glycogen, are not regarded in this method to an extent which could be considered as excluding all errors.

(c) Method of Quantitative Determination of Glycogen, According to Lebbin.

Lebbin demonstrated that glycogen may be precipitated from meat solutions by alcohol, whether the solution has an alkaline,

neutral or acid reaction, while the precipitation of protein with iodin ceases when the alkalinity of the latter reaches a certain degree. It is possible, therefore, to precipitate glycogen directly from protein solutions by means of alkaline alcohol. According to Lebbin, however, it is desirable to purify the crude glycogen, since small quantities of protein may be carried with it. The method is as follows:

Muscle meat or sausage is to be minced with a small sausage machine. Liver may be cut up simply with a knife. Then, in the case of horse meat or liver, twenty grams; in the case of other kinds of meat, containing less glycogen, a correspondingly larger quantity, is to be placed in a porcelain vessel containing 150 cc., together with 90 cc. of water and 10 cc. of a 15 per cent. potash lye, and the whole is to be heated until completely dissolved. Boiling for a short time does no harm. Muscle meat requires from one-half to one hour; liver, a shorter time. During this treatment the fluid is evaporated to from 30 to 35 cc. It is then poured into a graduated cylinder containing 50 or 100 cc., and the vessel is washed with water until a volume of 50 cc. is obtained. After vigorous shaking, the solution is poured through glass-silk. By means of a pipet, 25 cc. of the fluid is to be placed in a beaker and 50 cc. of alkaline alcohol added. This is obtained by mixing ninety parts of a 98 to 100 per cent. alcohol and ten parts of a 40 per cent. potash lye. The precipitated crude glycogen settles after from two to three hours. It is desirable, however, to cover the mixture and allow it to stand over night. The mixture is then filtered and washed with the alkaline alcohol. Thereupon the funnel,with the filter and precipitate, is to be placed upon a graduated cylinder of 100 cc. volume. The filter is to be punctured with a platinum needle, and the material of the filter is to be washed in the cylinder with hot water, 80 cc. being the maximum quantity required. The mixture should then be vigorously shaken, in order that all the glycogen may dissolve, and is allowed to cool. Two or three drops of litmus tincture is added to the solution, and 10 per cent. hydrochloric acid is to be added in drops until the fluid becomes red, after which three or four more drops should be added. Next, the mixture should be diluted with from 5 to 10 cc. of Brücke's reagent and water sufficient to make 100 cc., after which it is again filtered. Of this filtrate, 50 cc. is withdrawn with a pipet and mixed with 75 cc. of 95 per cent. alcohol which has been carefully poured through cotton batting. The next morning it is filtered through a quantitative tared filter, washed with alcohol, then with ether, and finally weighed. Finally, one may make a

determination of the ash and subtract the sum. Lebbin, however, always obtained a glycogen free from ash. The quantity of glycogen obtained, multiplied by twenty, corresponds to the same percentages in the meat which was tested.

Demonstration of Horse Meat, According to Hasterlik.

Horse fat is distinguished from the fats of other food animals by its high absorptive power for iodin and by its high iodin number, according to Hübl. It possesses an iodin number of from 74 to 83, as contrasted with 40 to 44 of beef tallow and 60.6 of lard. The differences in the iodin number, according to the investigations of Hasterlik, extend also to the intramuscular fat. In the intramuscular fat of beef, Hasterlik found the iodin number to be from 49.74 to 58.45 (an average of 54.37); in horse fat, on the other hand, from 79.71 to 85.57 (an average of 82.23). The fat of horse-meat sausage on the market, in consequence of the addition of lard, showed a somewhat lower iodin number, namely, from 68.46 to 79.71.

These differences, according to Hasterlik, make possible a determination of the origin of meat, even when the coarser adipose tissue, which is distinguishable by the naked eye, has been removed; as, for instance, in conserves. Hasterlik considers that the presence of horse meat is demonstrated when the iodin number reaches or exceeds 80.

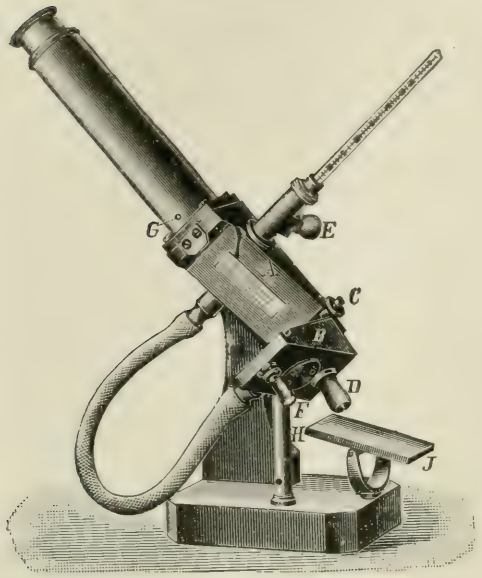
In order to obtain the intramuscular fat, meat which is entirely free from visible fat is finely minced, and a quantity of from 100 to 200 grams is dried for from twelve to eighteen hours at a temperature of 100° C. The dry substance is then extracted with petroleum-ether on a reflux cooler for six hours, and then with the same solution, for the same length of time, in a Soxhlet extraction apparatus.* After mixing both extracts, namely, that obtained from the reflux cooler, and that from the Soxhlet extraction apparatus, the petroleum-ether is distilled away, and the last traces of it are so completely removed by blasts of air into the extract that no smell of the petroleum-ether is to be detected.

According to Bremer, the determination of the iodin number of the fluid-fatty acids of the intramuscular fat forms a suitable complement to the determination of the corresponding number of the fat. In horse-meat sausage, to which lard is added to the extent of 25 per cent., he found the iodin numbers of the intramus-

* Bremer calls attention to the fact that the petroleum-ether extract from horse meat is colored red or dark-brown red in a characteristic manner.

cular fat to be 53.7, 74, 74.1 and 75.8, and the iodin numbers of the fluid-fatty acids of this fat to be 92.4, 104.1, 102.1 and 108.8. Bremer considers that the presence of horse meat is certainly demonstrated when the preparation is colored reddish-brown, or gives a strongly reddish-brown colored petroleum-ether extract, or contains glycogen, or when the iodin number of the fat exceeds 65, and that of the fluid-fatty acids considerably exceeds 95.*

Fig. 24.



Zeiss' refractometer.

Nussberger proposes a refractometric determination of horse meat. He found the refractive index of horse fat in a Zeiss refractometer (Fig. 24) at a temperature of 40° C. to be 53.1 to 54.1 (on an average, 53.5), while the refraction number of beef tallow never exceeded 49, and that of lard never exceeded 51.9. The intramuscular fat of horse meat showed an average refraction number of 56.3 (55.2 to 59.8), while the intramuscular fat of beef showed 49.7 (48 to 50.5).

Appendix.—Inspection of German and American Bacon.

Relative to a suit at law in Köln on account of the smuggling of American bacon, the following opinion was handed down on the question at issue. Rehmet investigated thousands of the sides of bacon in question, and demonstrated that all possessed black hairs. They also possessed a characteristic odor, like the oil of tar, which was especially noticeable in cooking, and could be perceived for days

* In accordance with this, Bremer considers as an evidence of horse fat or horse meat an iodin number lower than that required by Hasterlik. On this point Bremer agrees with Nussberger, who found the iodin number of the intramuscular fat of horse meat to be on an average 71.9 (65 to 79), as contrasted with an average of 51 (50 to 58), in similar beef fat. In ordinary horse fat, Nussberger determined the iodin number to be from 80 to 94; in beef tallow, 35 to 44; and in lard, 59 to 63.

on the fingers and receptacles. The bacon tasted rancid. Furthermore, it frothed strongly and shrunk in cooking. None of these characteristics were observed in Dutch or German bacon. In fact, only a small percentage of Dutch and German hogs have black hair. According to Lubitz, the bristles in the rind of American bacon are not uniform, but stand in an irregular, brush-like manner. Furthermore, the rind is thinner. Schmidt, of Aachen, found that more than three-fourths of the sides of bacon in question were covered with black hairs. Schmidt also called attention to the fact that he had previously inspected American bacon for trichina, and had found from 5 to 10 per cent. trichinous.

3.—Recognition of the Age and Sex of Slaughtered Animals, and Classification of Food Animals.

The determination of the age and sex of living animals, as a rule, offers no difficulties. In the meat of slaughtered animals it is quite otherwise.

The necessity for determining the age and sex of slaughtered animals arises from several considerations. One consideration is the usual compilation, in meat markets, of statistics with regard to the age and kind of food animals in general, as well as on the relation between age and sex and certain diseases. Furthermore, an accurate determination of the age is necessary in legal cases, and for fixing the slaughter and insurance fees. Finally, a consideration of the age and sex are required in judging of certain pathological processes.

(a) Age.

Determination According to the Condition of the Teeth.

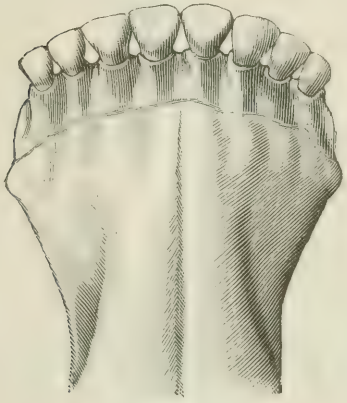
The age of living animals, in the first place, is determined according to characters furnished by the development and changes in the incisor teeth.

1. The Horse.—The first two incisor teeth, at birth; the middle incisors, four to six weeks after birth; the corners, six to nine months after birth. The milk incisors are white, and furnished with an evident neck; the shedding of the central incisors, two and one-half to three years; of the middle incisors, three and one-half to four years; of the corners, four and one-half to five years. The permanent teeth are yellowish, without a neck, and furnished with furrows on the labial surface. The further determination of age in

horses is made according to the degree of wear. This is indicated until the ninth year in the incisors of the lower jaw, and until the twelfth year in those of the upper jaw, by the loss of the marks; later, by the so-called round, triangular and inverted oval grinding surface of the incisors (from twelve to eighteen years; from eighteen to twenty-four years, and, lastly, from twenty-four years on).

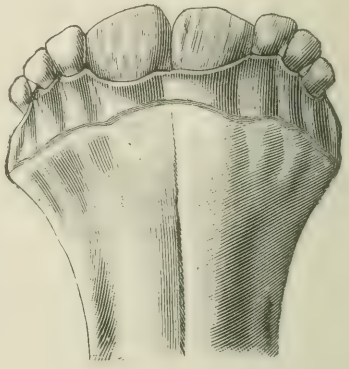
2. CATTLE.—Concerning the determination of the age of calves, more detailed data are given in the discussion of immaturity. As a rule, cattle retain the milk incisors for eighteen months. The milk incisors are considerably smaller than the permanent teeth in cattle.

FIG. 25.



Incisor teeth of a beef animal one year old.

FIG. 26.



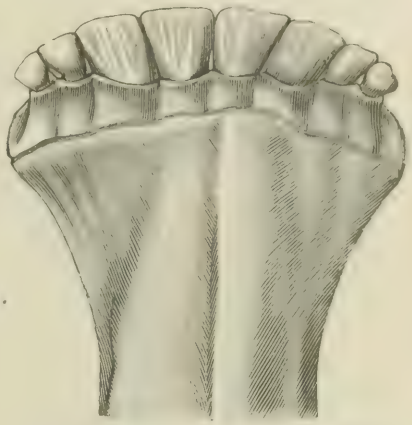
Incisor teeth of a beef animal one and one-half years old.

The teeth of old animals, however, may come to resemble the milk incisors in point of size, and, in fact, this similarity has already given occasion in slaughterhouses to errors in judging the age of animals under one and one-half and over ten years. By making a careful examination, however, even of the teeth alone, and when the horns and the condition of the symphyses do not enter into consideration, such mistakes are impossible. For the teeth of such old cattle project so far out of the alveoli that a large part of the root is visible. Furthermore, even if some doubt is still entertained, it is easy, by exposing the alveoli in the jaw of a slaughtered animal, to convince one's self whether the permanent teeth, which have not yet broken through, are present together with the visible incisors.

The German Agricultural Society has established the following rules for the determination of the age of German cattle:

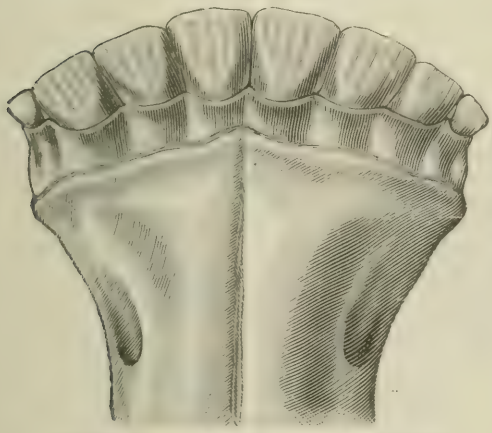
As a rule, the first change of teeth occurs at the age of one and one-half years. The central milk incisors fall out, the permanent central incisors appear and attain their full height at the age of two years. At the age of two and one-half years, the inner middle incisors fall out. The corresponding permanent incisors grow to their full height toward the end of the third year, and come into wear. As a rule, from the age of three and one-quarter to three and one-half years, the external middle incisors fall out, and the permanent incisors come into wear during the fourth year. At the age of four and one-quarter to four and one-half years, the milk corners fall out, and the corresponding permanent teeth come into wear during the end of the fifth year. At the completion of the change of teeth, good criteria for judging are obtained in the wear of the incisors and in the

FIG. 27.



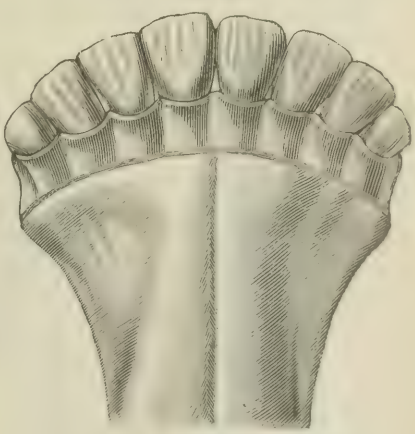
Incisor teeth of a beef animal three years old.

FIG. 28.



Incisor teeth of a beef animal four years old.

FIG. 29

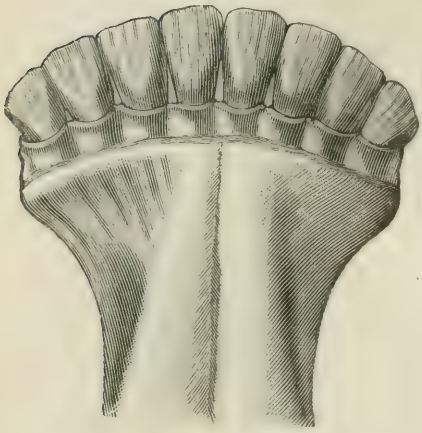


Incisor teeth of a beef animal four and one-half years old.

gradual appearance of the neck. The neck of the central incisor teeth becomes noticeable at the age of six years; that of the inner middle incisors at seven years; that of the outer middle incisors at

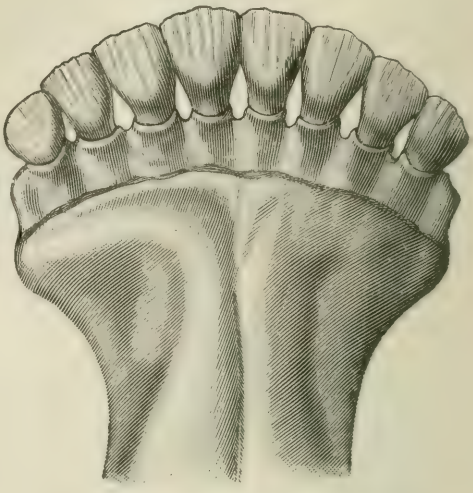
eight years, and that of the corners at nine years. In animals which are over ten years of age, all inner middle incisors are

Fig. 30.



Incisor teeth of a beef animal six years old.

Fig. 31.



Incisor teeth of a beef animal eight years old.

strongly worn, small, loose, project far out of the alveoli, and are separated from one another. After fifteen years, the incisors either fall out or are present in the form of stumps.

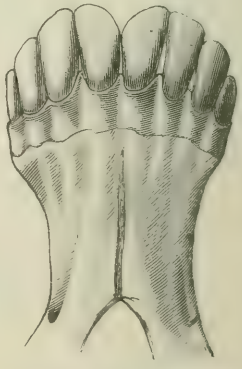
Fig. 32.

Incisor teeth of a yearling sheep.

Fig. 33.

Incisor teeth of a four-year-old sheep.

Fig. 34.



Incisor teeth of a six-year-old sheep.

3. Sheep.—The sheep is born with the central incisors. The inner middle incisors appear at from eight to fourteen days, the

external middle after two to three weeks, and the corners at from three to four weeks. The shedding of the teeth begins with the central incisors at the age of from twelve to eighteen months; next follow the internal middle incisors at from one and one-half to two years; the external middle incisors at two and one-quarter to two and three-quarters, and the corners at three to three and three-quarter years. The chief point in the case of sheep is the differentiation between the still uninjured milk dentition and the completely developed permanent dentition (Figs. 32 and 33). The dental conditions in older sheep possess little practical interest. It may simply be remarked that after six years the incisors show a notch (Fig. 34), and fall out at from ten to twelve years of age.

4. Hog.—At birth the hog has the third incisors and the canine teeth. The first incisor appears at from two to four weeks, and the second at from two and one-half to three months. The third incisor is shed first at nine months (according to Nehring, at seven and one-half months). Then follows the first incisor at from twelve to fifteen months, and, finally, the second at from sixteen to eighteen months.

5. Red Deer, Fallow Deer and Roebuck.—According to Nehring, the shedding of the teeth in these animals occurs in the following manner:

Name of Teeth.	*Red Deer.*	*Fallow Deer.*	*Roebuck.*
Incisor 1	After 15 mos.	After 9–10 mos.	After 6–8 mos.
Incisor 2	After 17 mos.	After 12–13 mos.	After 10–11 mos.
Incisor 3	After 20 mos.	After 15 mos.	After 12 mos.
Incisor 4	After 22 mos.	After 18 mos.	After 13 mos.
Premolars	After 30 mos.	After 24 mos.	After 14–15 mos.

Different opinions have prevailed on the question of what is to be understood by the term calf, or fawn, in the case of red deer, fallow deer and roebuck. According to Sec. 6 of the Hunting Law, of February 26, 1870, young game is considered as calves until the last day of December following their birth. For a long time police regulations followed the practice of admitting young game for sale if it weighed not less than twenty-two pounds. On the other hand, Nehring handed down the opinion that a twenty-two pound deer was suitable for sale, but that a deer which did not possess a complete set of molar teeth, and had less than six teeth, must be regarded as a calf.

Other Criteria for Judging Age.

Besides judging according to the teeth, it is a well-known custom to judge the age of cows according to the rings on the horn, adding two to their number. But this characteristic is at best only supplementary to the dental conditions, since it can not be considered as possessing absolute reliability, for the rings on the horns are formed regularly only when the animals have been regularly pregnant. This, however, is by no means always the case. At the same time, irregular intervals between the rings on the horns permit the conclusion that pregnancy has been irregular.

Finally, particular parts of the skeleton furnish us certain criteria for the determination of age:

(a) The cartilaginous pads, between the diaphyses and epiphyses, which disappear after the growth of the bones is complete.

(b) The articular cartilages, which connect individual bones with each other, ossify with increasing age. The degree of ossification of the ischio-pubic symphysis furnishes an especially valuable criterion for determining whether one is dealing with the meat of an old or a young animal. This symphysis is always cut through in slaughtering. In young animals this can be readily done with a knife, while in older animals it is necessary to make use of a saw or an ax. The sternal cartilages ossify in the median line during the second year.

(c) The supplementary and organic cartilages of the ribs, spinous processes, scapula, trachea, ear, etc., which in old age become calcareous and ossify. According to Bunge, the supplementary cartilages of the spinous processes in cattle are cartilaginous only during the first years of life. Later they ossify and become completely ankylosed with the spinous processes. Up to the end of the first year, the supplementary cartilages are very sharply marked off from the bones, which are rich in blood. During the second and third years, the cartilage shows larger and larger islands of bone substance, and the white color of the cartilage is consequently changed into a grayish-red. Toward the end of the sixth year, the larger part of the supplementary cartilage becomes modified into a compact bony tissue. A very sharp line of demarcation is still visible between both parts, and a cartilaginous border is observed on the former supplementary cartilage. At the end of the eighth year, no cartilage is demonstrable, as a rule, in a longitudinal section of the spinous process.

(d) The tubular bones, in which, after birth, the marrow cavity becomes gradually larger, and fat marrow is formed. In old animals a serous, infiltrated, gelatinous tissue replaces the fat marrow.

The difference in color of the musculature and fat tissue of young and old animals has already been mentioned (pp. 199–204).

Age of Fowls.

In handling fowls a distinction is made, as a rule, only between old and young birds. For this differentiation, the following rules are to be observed :

Young hens possess only the beginning of the so-called spurs. Furthermore, the scales on the feet are smooth and of a glistening, fresh color. The claws are delicate and sharp. The tarsus is soft, and the comb is thin and smooth. In old hens, the spurs are hard and the scales on the feet rough. Furthermore, the lower half of the bill is so hard that it can not be bent with the fingers. Lastly, the comb is thick and rough. According to Cornevin, the young rooster, up to the age of four and one-half months, possesses only the indication of a spur in the form of a broad scale. From four and one-half to five months on, a small protuberance develops in the form of a spur, which at seven months is 3 mm., and at one year, 15 mm., long and straight. At two years the spur, which has become curved, is from 25 to 27 mm. long; at three years, from 36 to 38; at four years, from 50 to 54; at five years, from 62 to 65. The breeds with feathered legs have shorter spurs than those with naked legs. The hen commonly has no spurs. Castration of the rooster checks the growth of the spurs.

Old hen turkeys also have rough scales on the feet, calluses on the soles of the feet, and long, strong claws. Young turkey cocks show exactly the opposite condition in all these points, and an old turkey cock with the feathers on possesses a long beard, which is entirely wanting in the young cock. When turkey cocks have been picked, the roughness of the scales on the feet is a deciding factor in determining his age, and also the difference in the size of the wattles and the nose piece. Cornevin asserts that the red, fleshy wattles appear in the turkey cock at from two and one half to three months, and the brush of bristles on the breast at from seven to eight months of age. Furthermore, the feet are black up to the age of one year; rose-red at from two to three years, and gray rose-red at from three to four years, becoming paler from that time on.

An old goose is to be recognized by its rough feet, strength of wing and beak, and fineness of feathers. In picked geese, the

following may indicate the age: The condition of the feet, the delicacy of the skin under the wing and wing points, the beak, and the thickness of the skin in general.

In ducks the age is determined in the same manner. It should also be remembered that the beak, in its relation to the width of the head, is considerably longer in young ducks than in old ones.

In pheasants (gold and silver), the plumage is dark up to the second year. This is not changed in the female even later, while in the male the gorgeous plumage and the long tail feathers are developed at two years of age.

Young pigeons are to be recognized by the paleness of their color, by the smooth, closed feet and long yellow down feathers, which are found scattered among the plumage. Older pigeons, after leaving the nest, have red-colored feet, but no down feathers. If the latter recognition marks are present, the pigeon is considered by fastidious persons as already too old for the table. Up to six or eight months of age, the beak is soft, but becomes hard later, according to Cornevin.

In young partridges, the beak is easily indented with the finger, but not in old birds. The feet of young partridges are yellowish, while in old birds they are gray.

According to Niebel, the condition of the wing feathers (extreme tip of the wing) offers in many species of birds a convenient means of judging age. The feather vane of the wing tip in the guinea hen, turkey, wood grouse, black grouse, hazel hen, white grouse, partridge and heath hen is pointed in young birds and more or less rounded in old birds. In the domestic fowl, turkey, wood grouse and pheasant, the development of the spurs, according to Niebel, is to be considered a good criterion for judging age. Furthermore, in all species of birds, the condition of certain bones (sternum, pubis, ischium) serves to indicate the age. The bones are flexible in young birds; later, are easily broken, but are broken with greater difficulty as the age increases. Finally, in young pigeons, according to Niebel, the breast muscles show through the skin as white, while in older birds they appear bluish-red.

(b) Recognition of the Sex of Slaughtered Animals.

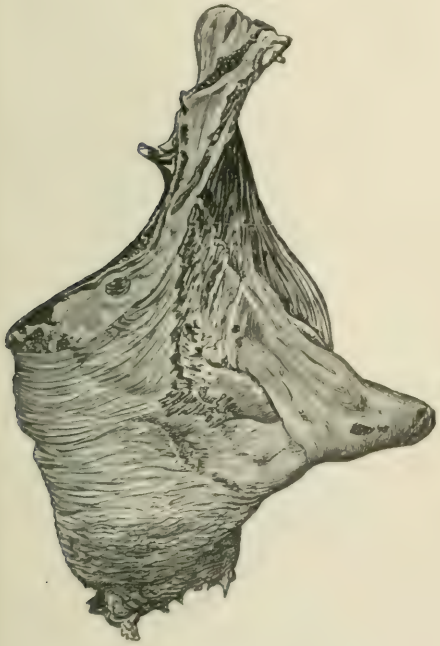
The recognition of the sex of slaughtered animals has a practical value in the case of cattle, sheep and hogs.

1. Cattle.—Bulls, steers and cows are slaughtered—spayed cows but rarely. Besides this, one speaks of young cattle, one-half

to one year old; heifers (young cows which never have never borne calves), and steers (young, unfattened oxen). The heifers and steers, in some parts of Germany, are sometimes included under the term "cattle," more correctly, young cattle.

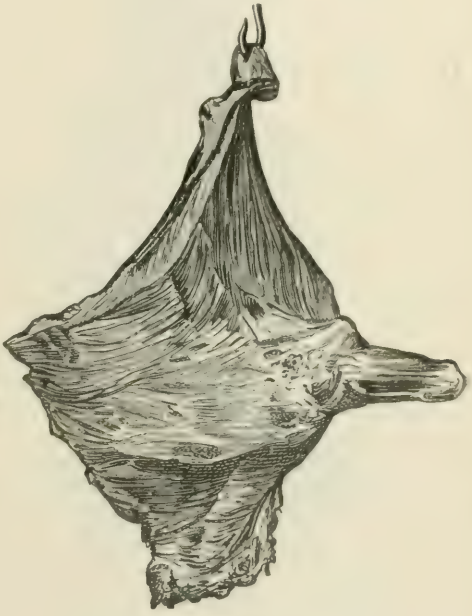
The bull is characterized by the massive development of his muscles, especially the neck and shoulder musculature (Fig. 35); also by the dark color of the musculature and the scarcity of fat tissue. Finally, the inguinal canal is open, for the reason that the

Fig. 35.



Fore quarter of a bull.

Fig. 36.



Fore quarter of a steer.

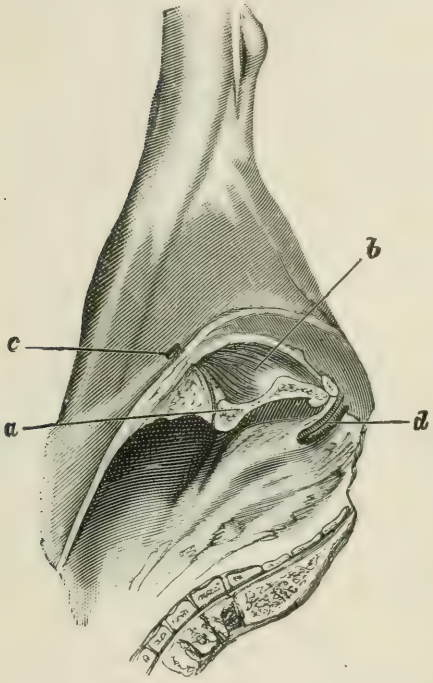
testicles, with the spermatic cord, are removed in slaughtering (Fig. 37, *c*).

The ox is distinguished from the bull by the weaker development of the shoulder and neck musculature (Fig. 36); by its thick panniculus adiposus, and by the possession of a scrotal fat tissue which completely conceals the inguinal ring (Fig. 38, *c*).

In cows the udder is often carefully removed, except for the conical-shaped remnant in the posterior part. This operation is performed in order to give female animals the appearance of steers. The attempted deception, however, is easily recognized by the mammary tissue which remains, and by the supramammary lymph

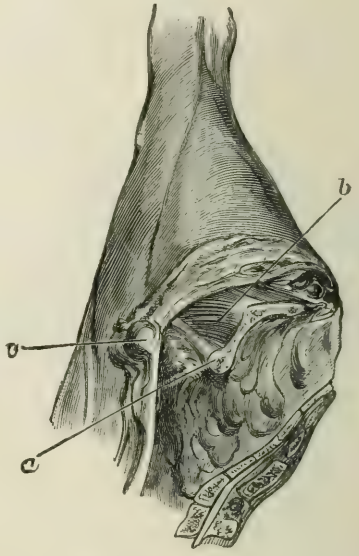
glands covering this tissue. Heifers possess an udder of only slight proportions, and, when in good condition, the udder is completely infiltrated with fat tissue (Fig. 39, *c*), as contrasted with the large, flabby, dependent udder of cows in lactation (Fig. 40, *c*). The udder of fattened cows, four to six years old, also shows a high fat content, but always exhibits a strongly projecting glandular substance and large teats.

Fig. 37.



Hind quarter of a bull. *a*, section of ischiopubic symphysis; *b*, cut surface of the gracilis muscle; *c*, external inguinal ring; *d*, portion of corpus cavernosum.

Fig. 38.



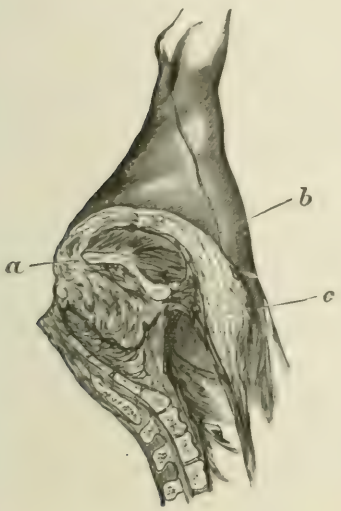
Hind quarters of a steer. *a* and *b*, as in Fig. 37; *c*, scrotal fat tissue.

Franck also called attention to the fact that a cross-section of the adductors of the thigh, which is, in fact, dependent upon the musculus gracilis for its form, is triangular in male cattle and bean-shaped or rounded, on the other hand, in females (Figs. 37 to 40, *b*).

Furthermore, a section of the pelvis in the symphysis pubis shows characteristic differences in male and female cattle (Figs. 37 to 40, *a*).

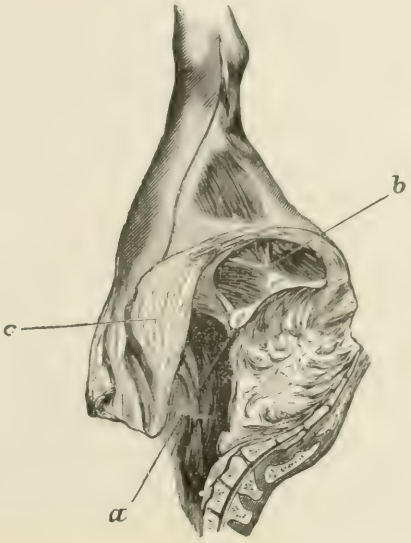
In the diagnosis of the skin, which is no longer in its natural connection with the animal, it should be remembered that the bull has straight, short and conical horns; the ox, curved, long and strong horns; and the cow, on the other hand, curved, short and slender horns.

Fig. 39.



Hind quarters of a heifer. *a* and *b*, as in Fig. 37; *c*, fatty infiltrated udder.

Fig. 40.



Hind quarters of a cow. *a* and *b*, as in Fig. 37; *c*, udder in lactation.

2. Sheep.—Distinction is made between bucks, male castrated animals or wethers, and female animals or sheep in the narrower sense. The slaughtered buck is distinguished from other sheep by the strongly developed musculature of the neck, withers and shoulder. The meat of bucks may also possess a disagreeable odor, but, as a rule, this is rare. The penis is left on slaughtered wethers, and the udder on the ewes; consequently, the differentiation of wether from ewe offers no difficulties.

In England and America, breeders strive to bring sheep as young as possible, yearlings, to a condition for slaughter. This practice is based on two facts: First, it has been determined by numerous weighings that, with intensive feeding from birth until the end of the first year, the sheep puts on twice as much flesh as in the second year. Secondly, the business risk is smaller the earlier the animal is ready for slaughter.

3. Hogs.—Fattened, castrated hogs (barrows), young boars not castrated, and breeding hogs (boars and sows) are brought to slaughter. Breeding hogs are distinguished from fattened hogs by the slight amount of fat and the stronger development of the musculature, which, likewise, possesses a darker color. Sows, furthermore, are to be recognized by the strongly developed mammary glands, and the boars by the so-called shield (p. 167) and specific odor.

Boars, which for some time have been in service and thereafter, at an age of one to one and one-half years, are castrated, are known as "castrated boars" or "old cutters." They show the boar type in the form of the skeleton, and are esteemed of less value than animals castrated earlier in life. The specific odor is wanting in castrated boars.

The term "originals" is used to mean cryptorchids. They may possess all the characters of true boars when the testicles are functional. However, this is not always the case. In slaughtering male hogs, the penis, together with the navel pocket, is removed. The slaughtered male hog is characterized by the cut. A further means of recognizing the male hog is found in the remains of the ischio-penal ligaments, which are found in the ischiac notch. In the female hog, the cutting line in the middle of the belly is straight, and the section underneath the root of the tail is, as Lohoff indicated, longer than in male animals, in consequence of the removal of the vulva.

Ellinger suggested the following characters for distinguishing between boars castrated late and early in life :

CRYPTORCHIDS	BOARS CASTRATED IN OLD AGE	BOARS CASTRATED WHEN YOUNG
Sexual excitement appears quickly	Partly present	Wanting
Smelling at the vulva	Wanting	Wanting
Urinous odor	Wanting	Wanting
Strongly developed canine teeth	Partly present	Slightly developed
Strong bristle crest	Partly present	Slightly developed
Shield	Partly present	Wanting
Penis 1.2 cm. in diameter	1.2 to 2.2 cm.	0.8-1 cm.
Cowper's glands 10-15 cm. long	Cowper's glands 10-15 cm. long	Glands atrophied
Post-mortem shows one retained testicle	Not present	Not present

National Economic Value of the Castration of Female Food Animals.

Modern breeding of races of hogs which mature early has almost entirely abandoned the previously quite general practice of castration of female hogs for fattening. Breeders assert that hogs which arrive at maturity early may, by rational feeding, be made ready for slaughter before estrum appears. This assumption, however, is contradicted by the finding in the slaughterhouses of a large proportion of fat female hogs which are pregnant. The extent to which this occurs appears from the reports of the Berlin Food Animal Insurance Company, the expenditures of which, in the year 1895, were not less than $11,540.60, as indemnity for the weight of the uteri of pregnant hogs. By castration, not only would this sum have remained in the general treasury, but also the profits of the feeders would have been greater, since castrated female hogs fatten more readily than pregnant ones.

The same may be said in the fattening of cows, upon the slaughter of which one may demonstrate, not without a feeling of great regret, a large number of almost mature fetuses. The fetuses represent offal without any value. In eastern Prussia, several large land owners commenced the castration of all cows intended for fattening. The results thus far obtained are favorable, and suggest an extension of the method, particularly since the operation is not only easily performed, but perfectly safe.

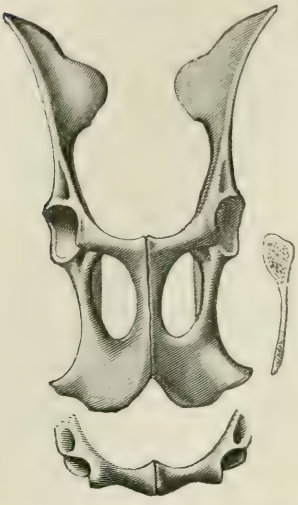
4. Distinction of the Sex of Eviscerated Roebucks.—For the distinction of the sex of deer, in which the skull is sawed out and the sexual organs removed, Eberhardt and Nehring offer the following important diagnostic characters: The pelvis of the buck is slender and narrower than in the doe. In the latter the external iliac angle is much further removed than in the buck, and the relation is about fifty to forty.

Of still greater importance for the determination is the form of the pubis, and especially the symphysis pubis, also called the "lock" by hunters. In the full-grown buck it is much thicker and of a rounder form than in the doe, in which it is flattened and hollowed out on its upper surface on both sides. The difference appears still more conspicuous in the symphysis pubis (Figs. 41 and 42). Similar sexual differences are found in the pelvis of the red deer and the fallow deer.

Nehring insists that the differentiation of the sex, according to the condition of the symphysis pubis, can only be made with cer-

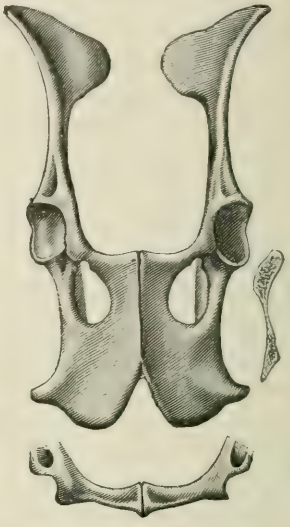
tainty in old roebucks, and Malkmus corroborates this on the basis of numerous investigations. Younger individuals have, uniformly, a somewhat tumor-like, swollen symphysis pubis. Furthermore, in the determination of the sexual differences in the roebuck, Malkmus recommends that the halves of the pelvis be separated and prepared by boiling.

Fig. 41.



Pelvis of a male roe deer.

Fig. 42.



Pelvis of a female roe deer.

(c) Classification of Food Animals.

The Conference of Delegates of German Slaughterhouse Officials, representatives of the German Agricultural Commission, etc., which was held in Berlin in 1895, decided upon the following classes for food animals, in the place of the previous distinctions, according to Secs. 1, 2 and 3.

Steers.

1. Steers in full flesh, completely fattened, of the highest slaughter value, up to seven years.
2. Young, fleshy, but not completely fattened, and older fattened steers.
3. Fairly well-nourished young steers; older steers.
4. Poorly nourished steers of all ages.

Heifers and Cows.

1. Heifers in full flesh, well fattened, of the highest slaughter value.
2. Cows in full flesh, well fattened, of the highest slaughter value, up to seven years.

3. Older cows, well fattened, but more poorly developed; younger cows and heifers.
4. Fairly well nourished cows and heifers.
5. Poorly nourished cows and heifers.

Bulls.

1. Bulls in full flesh, well fattened, up to five years.
2. Younger bulls in full flesh.
3. Moderately well-nourished younger and older bulls.
4. Poorly nourished younger and older bulls.

Calves.

1. The finest fat calves (fattened on milk) and the best sucking calves.
2. Medium fat calves and good sucking calves.
3. Poor sucking calves and older poorly nourished calves (feeders).

Sheep.

1. Fat lambs and young fat wethers.
2. Old fat wethers.
3. Fairly well-nourished wethers and ewes.

Hogs.

1. Hogs of the finer breeds and their crosses in full flesh, up to one and one-quarter years.
2. Fleshy hogs.
3. Poorly developed hogs, together with sows and boars.
4. Foreign hogs, with a statement of their origin.

The Conditions for Issuing Meat Intended for Troops.

Meat intended to be issued to troops must be from healthy, not too poor food animals. The best quality is not required, but it must be good. Poor quality is excluded. The animals must be in a good state of nutrition. Good products are always to be furnished to garrison commissaries.

The meat of bulls, bucks, boars, including animals castrated late in life, breeding sows and Bakonyi hogs, can not be issued to troops. The meat of breeding ewes may be furnished to troops, but not to garrison commissaries.

Steers must be from two to seven, and cows from two to six years old, and must possess a live weight of at least 400 kg. Wethers and ewes must not be over five years old, and their live weight must be at least 40 kg. Hogs must be from six to fifteen months old, and must have a live weight of not less than 75 kg., and not more than 125 kg. Calves must be at least four weeks old.

The following materials are not to be furnished to troops as meat: Head, bloody neck portion, udder, front legs below the knee,

hind legs below the hock, in the case of cattle; the head and legs of wethers, and the udder of ewes; the head, with the cheeks, the legs and the dorsal fat of hogs; the head, the bloody neck portion, and the legs of calves; the internal organs (heart, lungs, liver, stomach, spleen, intestines and kidney, including the kidney fat), as well as special portions of bones, in so far as they come into consideration in weighing the meat which is to be furnished.

VI.

ABNORMAL PHYSIOLOGICAL CONDITIONS WHICH POSSESS SANITARY INTEREST.

The abnormal physiological conditions in food animals can be classified into (1) physiological abnormalties and (2) pathological processes. The following subjects belong to the first group:

1.—Immaturity.

Definition.—Animals are characterized as immature until they have reached the age of from eight to fourteen days. Until this age, according to the view of most meat consumers, animals are not ripe or mature for the table. Most frequently immature calves and, much less often, immature pigs, lambs and goat kids are offered for sale. During the first eight to fourteen days after birth, animals exhibit a poorly developed, gray-red, flabby, strongly water-soaked musculature. These characteristics are especially prominent in the muscles of the thigh. If one grasps the musculature of the thigh from behind, it is noticed that in immature animals a flat, flabby readily movable muscle-mass is present in place of the full, convex muscle mass in older calves. Furthermore, the musculature of the posterior part of the thigh possesses such a soft consistency that it is easily penetrated with the finger. The fat tissue which is found in the kidney capsule in immature calves is of a yellowish or gray-red color and peculiarly tough consistency. It never possesses the white color and soft consistency, which becomes firm in setting, as observed in older calves. The subjective ideas concerning immaturity exhibit great local variations. For example, while in South Germany a minimum age of three to four weeks is demanded for the slaughter maturity of calves, in other regions, as in Mecklenburg and Holstein, calves from two to three days old are much sought after. In Berlin, calves from six to eight days old furnish a highly-prized food material. This is due to two circumstances: In the first place, intensive dairying, in which all calves not intended for rearing

are quickly rejected, has introduced a custom to which meat consumers in the course of time adjusted themselves. Furthermore, the price of immature, or fasting, calf meat is naturally less than that of older calves, so that it becomes possible for persons of moderate means to eat veal—a luxury which otherwise would be denied them. Finally, by the art of preparation, especially by the plentiful addition of fat, it is possible to improve the original condition, and in this manner to prepare a palatable food from immature veal. In the greater part of Germany, in common parlance, calf meat is understood to mean that which comes from calves at least eight to fourteen days old.

Official Determinations of the Meaning of Immaturity in Calves.

In the regulations of meat inspection and local ordinances, the following rules are laid down: Section 11 of the Baden Meat Inspection Regulations of November 26, 1878, provides that the meat of calves under fourteen days of age shall not be regarded as marketable. An ordinance concerning compulsory slaughter in Dessau prescribes that only calves over ten days old and with a minimum weight of 45 kg. can be slaughtered. In Insterburg, Rastenburg and Swinemünde, the meat of animals under eight days old is excluded from the market. Special ordinances forbid the sale of calves in which the navel has not healed. In Stolp and Haynau the matter is decided according to each individual case; likewise in Berlin. Here there is no minimum age limit for the admission of calves for food, but in each individual case the development and consistency of the musculature are the deciding factors. Calves in which the stump of the umbilical cord has not become united with the navel are regularly excluded from the market.

Young pigs (sucking pigs) and the young of sheep and goats (Easter lambs and kids) must be at least three weeks old before they can be considered as mature for slaughter.

Recognition.—Immature veal is to be recognized by the peculiar properties of the musculature and fat tissue, which are mentioned above as characteristic of immaturity. Lydtin also calls attention to the presence of red bone marrow in the long tubular bones in place of the fat marrow which appears later. The bone marrow, however, according to my investigations, becomes pale very rapidly after birth, so that the color of the bone marrow can not be regarded as a reliable means of recognizing immaturity. Of greater

importance is the high content of glycogen in immature veal. This persists from the fetal period and gradually disappears a few weeks after birth (see pages 213 and 242).

For the determination of the age of calves, which in many localities is considered as deciding the question whether they shall be admitted for food, we have the following criteria in the condition of the hoofs, teeth, navel and horns:

New born animals have soft hoofs furnished with conical processes on the soles. The stump of the umbilical cord is still of a gray, moist character, and hangs fast to the umbilical ring. The vessels of the stump of the umbilical cord, as well as the hepatic portion of the umbilical veins, and those portions of the umbilical arteries which lie in the lateral ligaments of the bladder, are open. Moreover, in new born animals the reddened gums stand flush with the incisor teeth and cover them in great part. The number of incisors varies in new born animals. As a rule, however, calves are born with six incisors.

Characteristic changes take place in the teeth and navel during the course of the first week. In the first place, the eruption of the corner teeth occurs during the first week after birth. In exceptional cases, however, this may occur later. After ten days (occasionally after seven days), the gums begin gradually to increase in redness, recede from the incisors, and assume the normal cushion form. After fifteen days, the middle incisors are free; and, after twenty days, the two corners are the only incisors not completely free from the gums, the redness of which no longer forms a striking contrast. By the end of one month, all the incisors have appeared through the gums and the latter are thenceforth of a permanent, normal character (Gerlach). After four or five days the navel becomes dry and black (necrosis). It falls off within two weeks (according to Gerlach, between eight and twelve days). Healing and cicatrization of the navel wound follow within two or three weeks, while the navel retraction takes place after the fourth week. The healing is much hindered by purulent processes in the navel. Morot collected statistics concerning the falling of the navel cord in the case of fifty calves. In seven cases the navel fell between the fifth and tenth day; in twelve cases, between the tenth and fifteenth day; in twenty-four cases, between the fifteenth and twentieth day; and in seven cases, between the twentieth and twenty-second day after birth.

The indication of the formation of horns on the frontal bones appears later. According to Gerlach, the thickening of the epider-

mis begins at the end of the second week. At the end of the third week, a hard, epidermal swelling is seen; after six weeks, an evident horn nucleus is formed; after eight weeks, complete epilation and development of the horn-cap; after three months, a movable horn-point appears, 3 cm. long in bull calves and 2 cm. in heifer calves, and with a length of 4 cm. and 3 cm., respectively, after four months. In bull calves, Gerlach found that the horn-tip was fixed after four months; while in heifer calves, on the other hand, it became attached after five or six months.

Finally, attention should be called to the change in color in the kidneys after birth (see page 175).

Thomassia demonstrated, in children, the following changes in umbilical vessels, which require substantiation by studies in calves. Even when life persists for only a few hours, the lumen of the vessels, arteries as well as veins, assumes a shrunken, almost star-shape cross-section in consequence of a strong contraction of the muscular layer, while, at the same time, the endothelium of the arteries acquires an opaque appearance, which becomes more and more apparent as obliteration progresses. The blood clots, which fill both vessels more or less completely, begin to turn pale from the fourth day, and on the fifth day show a decided tinge of yellow. From this time on, it is apparent that a slight adhesion occurs between the coagulated blood, which previously lay free in the lumen, and the walls of the vessel. After the twelfth day, the characteristic processes of the organization of a thrombus begin, and, accordingly, the lumen of the vessel becomes continually narrower. The process in the vein varies according as the lumen is free from blood clots, in which case the closure takes place through proliferation of the endothelium, or as the lumen is filled with a blood clot, as it frequently is. In the latter case, the histological processes resemble those in the arteries, both with regard to the organization and the change in color, which in time assumes more and more of a reddish-yellow tinge. By the forty-fifth day the lumen of the artery is usually closed by the complete formation of a thrombus, and its transformation into a ligament becomes perfect. The individual layers of the arterial walls are thin, and difficult to distinguish from one another. Similar conditions are observed in the vein, which, whether from the process of thrombus formation or from the adhesion of the proliferated endothelia, also loses its vascular character, and is changed into a solid cord. While, however, it is often possible to recognize the previous lumen as a point in a cross-section of the vessel at the time in question (six weeks after

birth), commonly, at the age of sixty days, the lumen has, without exception, entirely disappeared.

Judgment.—The meat of immature calves is not harmful. Occasionally, the opinion is held that immature veal exercises a peculiar characteristic, physiological action on the human organism, causing the occurrence of diarrhea and illness. This opinion is, scientifically, without foundation (Schmidt-Mülheim). On the other hand, immature meat is a spoiled food material, and is only to be admitted for sale under declaration. Its unfit character appears from the incomplete development of the meat, and from the subjective repugnance of the majority of meat consumers toward it. With regard to the latter point, it is necessary to consider the difference in custom in different regions.

The decision, that calves under eight days of age are not to be offered for sale under any circumstances, is a measure well calculated to check the practice of culling out immature calves and marketing them for slaughter.

2.—Meat of Fetuses.

The meat of fetuses is never a marketable food material. Only among English gourmands is the meat of fetuses considered a delicacy, as was the case among the Romans. In localities, however, without regular meat inspection, all strongly developed bovine fetuses are falsely offered for sale as veal in the form of bratwurst.

Recognition.—In those cases in which it is required to determine whether there has been a false substitution of fetus meat in the place of veal, those parts which usually betray the fetus to the layman, namely, the skin (with the umbilical ring), the hoofs, head, stomach and intestines, are, as a rule, not present. Nevertheless, the expert is in a position to determine with certainty, and without difficulty, the fetal character of the meat from the atelectatic condition of the lungs (they sink in water), from the open urachus, and the wide-open condition of the umbilical veins and arteries. Especially, the point where the latter branch off from the internal pudic arteries may make possible a final decision in those cases in which the entrails and umbilical ring have been removed. The liver, on account of its high value, is regularly included in the sale. A further means of recognizing fetal meat is to be found in the watery, flabby condition of the musculature, gelatinous condition of the connective tissue in

the region of the kidneys, which first shows a sparse accumulation of yellow fat soon after birth and the presence of a red marrow in the tubular bones. Finally, fetal meat is distinguished by its high glycogen content. By the demonstration of glycogen, the origin of individual pieces of meat and worked-over fetal meat can be determined (see page 213).

Niebel obtained from 400 grams of the meat of an almost mature calf-fetus, 7 grams of glycogen by boiling three times, and from 6 kg. of a fetus, at full term, 88 grams of glycogen by one boiling.

Judgment.—According to a decision of the Second Criminal Senate of the Imperial Court, of January 3, 1882, the meat of calf fetuses (so-called unborn calves) is to be considered as an unfit food material, because the normal condition is not present; but not only this fact, but also the character of the object itself stamps fetal meat as unfit food material. The meat of fetuses is, moreover, in all civilized countries, considered as highly unfit for human food, for esthetic reasons, and is excluded even from qualified sale under declaration.

3.—Poorness.

With insufficient nutriment, or during excessive organic functions, and, in general, during disturbed relations between ingestion and assimilation, domestic animals frequently exhibit that condition of nutrition which is characterized by the term "poorness." This condition appears in old age, in consequence of a failure in the power of assimilation on the part of the organism. It is characterized by the scarcity of fat tissue, and by an increase in the consistency of the musculature and its darker color.

Judgment.—The meat of such poor animals, in some regulations for meat inspection, is characterized as unmarketable; that is, as unfit for human consumption. This, however, is not right, for the meat of poor animals contains, as was shown on page 192, more protein than the meat of fat animals. Its flavor, as compared with that of fattened animals is, of course, considerably less agreeable. It shrinks in cooking, becomes tough, and acquires an insipid, dry taste. The meat of poor animals is, therefore, less palatable than the meat of fat animals. Nevertheless, it is not necessary to require a declaration, for the reason that the meat of poor animals declares itself through the scarcity of fat tissue, without any legal requirements. In this regard, the public needs no protection.

Moreover, in the case of food animals, we do not have to deal with the highest degree of poorness. A regard for the utilization of the meat prevents the slaughter of the poorest animals.

Furthermore, the meat of poor animals is indispensable for the manufacture of sausage. However, in working over sausage the quality of the meat in question is much improved as a food material, in consequence of its mechanical mincing and the addition of lard. It is, therefore, to the interest of meat consumers that the meat of poor animals should come into market in this more desirable form.

4.—Emaciation.

Frequently, the terms "poorness" and "emaciation" are confused, in spite of the fact that they refer to entirely different conditions. In the practice of meat inspection, especially in judging the meat of tuberculous animals, it is important to distinguish between emaciation and poorness.

Distinction between poorness and emaciation.—Under ordinary circumstances, there is a whole series of food animals which are poor; viz., all animals in the process of development, the majority of male breeding animals, and, finally, all cows of heavy milking races, which are slaughtered during lactation, or immediately after, without previous fattening. Poor animals are much sought after, because they furnish materials which are indispensable in sausage. For example, bulls bring a higher price when poor than when fattened. Fattening is, therefore, scrupulously avoided in these cases.

The objection might be raised that all veterinarians entrusted with meat inspection would not be in a position to determine by the carcass, without having observed the animal during life, whether he was dealing with poorness or emaciation in individual cases, for the reason that the emaciation of fattened animals may reach the degree of poorness of animals which have not been fattened, or may stop at that point. This objection, however, is, as a rule, not justified.

Poorness is a physiological condition present in perfectly healthy individuals. All the organs are normally developed, but the fat content of individuals is relatively small. Emaciation, on the other hand, is a pathological condition, or a condition which appears in old age, during which the ordinary nutritive condition sinks below

the normal.* Not only is there a loss of the fat laid on during the process of fattening, but usually an atrophy of the organs also appears, including the skeletal musculature. An approximate idea of the atrophy of individual organs in pathological or senile emaciation is furnished us by data on the loss of weight of fasting animals. A fasting cat, for instance, lost, according to von Voit—fat, 97 per cent.; spleen, 66.7; liver, 53.7; muscles, 30.5; kidneys, 25.9; lungs, 17.7; and heart, 2.6 per cent. In two other experiments with dogs, the musculature lost 43 per cent. of its original weight.

In addition to the more or less complete disappearance of fat, and the decrease in size of the spleen and liver, a decrease in the volume of the musculature appears in emaciated food animals. When this is connected with the disappearance of the fat deposited between the muscle layers and the muscle fibrillæ, a soft, flabby condition of the musculature is unmistakable, even in early stages. This is especially well shown in a comparison of healthy and emaciated bulls. Healthy bulls, in spite of the complete absence of fat, possess strongly convex muscle contours. The muscles feel full and firm. In emaciated bulls, on the other hand, the musculature is sunken, flat, flabby and soft. A high degree of emaciation, as is well known, is commonly associated with the serous infiltration of the subcutaneous retro-peritoneal and intra-muscular connective tissue. Gelatinous tissue replaces the fat tissue. Simultaneously, with a high degree of emaciation, a grayish-red discoloration of the musculature appears.

Judging emaciation.—The decision on the meat of emaciated animals is essentially determined by the cause of the emaciation. The meat, however, under all circumstances, even in emaciation in old age, is unfit for food on account of the important anomalies in the musculature. If a slimy degeneration of the fat, or a serous infiltration of the musculature has already taken place, the meat is

* Emaciation, therefore, appears suddenly (in serious fever), or gradually in chronic disturbances of metabolism. In the case of the sudden appearance of emaciation, in consequence of acute, wasting diseases, such pronounced changes are present in the parenchyma of the organs (cloudy swelling), as well as in the fat tissue (reddish coloration, and obliteration of the structure), that all doubt is removed concerning their meaning. In this place, therefore, only the more important chronic emaciation, which takes place in cattle, will be considered. Naturally, this must attain a certain degree before it acquires symptomatic significance. In consideration of this fact, reference is not made in regulations concerning procedure with the meat of tuberculous animals which are beginning to become emaciated, but to those which are already emaciated.

to be condemned as highly unfit for food. But, in those cases in which the emaciation is the consequence of disease, the decision is made dependent upon the nature of the disease (see under Oligemia, Hydremic Cachexia and Tuberculosis).

5.—Abnormal Coloration of the Adipose Tissue.

In discussing the normal properties of fat tissue, attention has already been directed to the fact that the fat tissue of cattle, on an exclusive grass diet, assumes a yellow instead of a white color. The meat of such animals is offered for sale without conditions, because it is, otherwise, of an unobjectionable character. In meat inspection, the only point of interest is to recognize the yellow coloration caused by feeding, and the difference between it and pathological icterus.

The yellow coloration caused by food is exclusively confined to the fat tissue. In jaundice, on the other hand, in addition to the fat tissue, the entrails, fibrous membranes (fasciæ, sclera and walls of blood vessels), cartilage, and, to a still greater extent, the muscles and bones, are colored yellow or discolored. Furthermore, upon a microscopical examination, an extensive accumulation of bilirubin crystals is found in the tissues, especially in the liver of icteric animals.

6.—Abnormal Odor of Meat.

This may be due to two different physiological conditions: (1) Excessive feeding with odorific substances, and (2) sexual activity of male animals.*

As a rule, meat of an unusual odor also has an abnormal flavor. The latter, however, is less pronounced than the former. For this reason it is desirable, in rendering judgment on the meat under investigation, to consider merely the abnormal odor.

1.—Abnormal Odor on Account of Improper Feeding.

The feed stuffs which, when given in undue quantities, transmit a disagreeable odor to the meat are fish (herring and smelt) and swill. In the first case, the meat assumes an odor like whale oil;

* With regard to other causes of abnormal odor in meat, compare the chapters on Intoxications and Post-mortem Changes, as well as the sections on Stomach Worms and Blackleg, in the chapters on Invasion Diseases and Infectious Diseases.

while, in the second, it possesses a disagreeable, heavy, or rancid odor. In both cases, the fat tissue acquires a consistency softer than normal, and is colored yellow or gray. Moreover, an abnormal odor of the meat is observed after feeding green fenugreek or decomposing turnips.

It was reported from Königsberg, in Prussia, that a part of the pork marketed there tasted so fishy that it either could not be eaten at all, or only with the use of strong condiments. The hogs came from the region of Labiau, where fattening was done entirely with smelt. In order to be certain, the slaughterhouse authorities of Königsberg invariably subject suspected meat to a boiling test before they admit it to the market.

Fenugreek (*Trigonella foenum-graecum*), which, in Germany, is used simply for medicinal purposes, is cultivated as a forage plant in southern France, Italy, and other southern countries. It furnishes a luxuriant green forage, which rapidly fattens animals. However, one objection to feeding with fenugreek is the fact that the meat assumes a very disagreeable taste, and an odor resembling hog dung. Mallet reported experiments which are chiefly concerned with the question whether the specific odor of fenugreek becomes definitely fixed in the tissues of slaughtered animals, or subsequently disappears from them. Mallet's investigations resulted in the following conclusions:

A single feed of fenugreek, in a green condition, is sufficient to transmit the odor of the plant to the meat. This odor completely disappears within four days thereafter. The odorous principle is more rapidly excreted when the plants have just blossomed than when they have already formed pods and seeds. But, even in the latter case, it is sufficient to stop feeding the fenugreek fourteen days before the sale of the fattened animals in order that the meat may regain its normal odor and flavor. The excretion of the odorous material takes place chiefly through the skin when the plants are fed in bloom; through the milk, urine and feces, on the other hand, if fed when the pods have formed. Consequently, the meat of calves is more seriously injured by the milk of cows which have eaten ripe fenugreek than by the milk of cows which have fed on the plants in bloom. Ollmann, in Greifswald, observed a case of abnormal odor and flavor of meat after feeding decomposing beets. A farmer fed 100 lambs with this material. The meat of these animals possessed a rancid odor and a soapy taste, in spite of the fact that they had received other feed for two days before slaughter.

In fowls, an oily odor, and flavor of the fat and meat, are frequently observed after fattening on rape seed, rape cake, and the refuse of oil manufacture. As is the case with swine, a flavor of whale oil is noted after extensive feeding with fish. This change is especially striking in turkeys and ducks which are fattened on rape cake or hemp seed, and in pigeons after a liberal feed of flax seed and colza. An oily odor and the flavor of whale oil are frequently present in Italian pigeons. Moreover, young geese from the region of Hamburg, and ducks from the Spreewald, often taste fishy. In these animals, however, the meat loses its disagreeable character if grain is fed for at least fourteen days before slaughter. A bitter flavor may appear in the meat of fowls which are fed to excess on turnips (Niebel). According to Labler, the flavor of the meat of ducks fed on clams is extremely disagreeable. According to this author, the meat of partridges, in January and February, in consequence of an exclusive diet of grass and germinating seeds, has an odor of whale oil. Niebel found that, in the fat of fowls with an oily taste, the iodin number is considerably increased. Thus, in normal turkey fat it was 75.48, while in oily fat it was 113.30.

2.—Abnormal Odor in Male Food Animals.

A specific odor is observed in sexually mature buck goats and boars. The odor is highly disagreeable, and is called buck-and-boar odor, since it can not be more definitely described. It is customary to speak of this abnormal odor, which is especially strong in the meat of the posterior part of boars, as urinous, because it possesses a certain similarity to the odor of decomposed urine. The flavor of the meat is also repulsive. Furthermore, in these animals during old age, the muscle fibers become tough and difficult to masticate; and, in the boar, the skin becomes in part chondrified with the formation of the so-called shield, which makes this part literally inedible, because it can not be comminuted with the teeth. The disagreeable odor and flavor of buck and boar meat is removed by castration. Obviously, castration should take place some time before slaughter, if the operation is to have the desired effect. Further investigation is required to determine whether the common practice of butchers in castrating goat bucks and boars immediately before slaughter has any influence on the odor of the meat.

The meat of cryptorchid boars, in which the retained testicles are atrophied, does not possess an odor more disagreeable than that of barrows (page 232). Furthermore, in actual boars and crypt-

orchid boars with functional testicles, the urinous odor is not always present. In fact, Goltz, during a period of four years, by careful boiling tests in the slaughterhouse at Halle, proved that boars and cryptorchid boars furnish neither malodorous nor ill-flavored meat. A repulsive odor and bad flavor were present in only 20 per cent. of the boars which were inspected, while in 80 per cent. the meat was of a marketable character. This finding agrees with the observation of Brebeck, who cooked portions of the meat of five cryptorchid boars—boiled, roasted, and ate them, without being able to detect any disagreeable odor.

Formerly, the opinion was quite general that, under certain conditions, the meat of buck sheep might possess a repulsive odor. This, however, is uniformly contradicted by the veterinarians of slaughterhouses. Thus, Goltz, to whom we are indebted for a good account of the animal odor of meat (Ztschr. f. Fleisch-u. Milchhyg., vol. 7), called attention to the fact that, during his long practice at the slaughterhouse, he never had an opportunity to observe a repulsive animal odor on the meat of buck sheep. It was also asserted that the abnormal odor is, frequently, only slightly developed in buck goats, and that this is the case even when the animals emitted a strong odor before slaughter.

Goltz also called attention to the occasional and exceptional presence of a repulsive odor and flavor in the meat of bulls. The odorific material, which during distillation of the meat passes over into the distillation product with the steam, resembles the odor of the perspiration of living bulls, and is present only in vigorous, moderately fat and well-developed bulls; but not in either run-down or fat animals.

Possibly, the declaration of bull meat, required in the old German meat inspection regulations, is to be explained by reference to the presence of this abnormal odor.

Demonstration of abnormal odor.—During the process of slaughtering, and while the animal heat is still present, the abnormal odor is quite pronounced. On the other hand, during the cooling process, it may disappear to such an extent as to be scarcely perceptible. In cold meat, however, it is possible to make the unusual odor again perceptible by heating a piece of the meat over a flame or boiling it in water.

In rendering a decision on boar meat, Goltz recommends that the boiling test should not be applied until one day after slaughter, for the reason that the meat of castrated hogs, when cooked

immediately after slaughter, possesses a peculiar, well-pronounced hog flavor, which is distasteful to many persons.

Judgment.—Odorous meat, under all circumstances, is an unfit food material, and, therefore, only to be sold at a freibank. If the odor is strongly developed, and, simultaneously, other abnormal conditions are present (discoloration, softening of fat, chondrification of the skin, etc.), seizure and condemnation are indicated. In boars and cryptorchids in which, as already indicated, the abnormal odor and flavor may be present, a decision is to be rendered according to the result of the boiling test in each case. With reference to the so-called fishy hogs, it is to be remembered that they are regularly eaten in the coast regions, while in the interior only a few purchasers for such would be found. Goltz demonstrated that, in ill-smelling bull meat, the unusual odor is commonly dissipated into the air after hanging two or three days. This fails to take place only when the odor is very pronounced. In such exceptional cases the meat may be made edible by steaming in a Rohrbeck disinfector (with live steam), since the odorous principle passes off with the steam. Goltz was also able to demonstrate in the odorous meat of buck goats, that the striking odor gradually disappeared when the meat was allowed to hang in the air. To be sure, this only occurs after fourteen days.

Advanced pregnancy.—Meat inspectors, with an insufficient training, have occasionally excluded from use, or have declared to be unmarketable, the meat of animals in an advanced stage of pregnancy. It is scarcely necessary to state, however, that this was without justification (compare Ostertag, Zeit. f. Fleisch-u. Milchhyg., vols. 7 and 8). Incidentally, it should be noted that, in buying food animals according to weight, pregnant animals are to be characterized as defective; for the sale of a food animal by weight (live or dressed weight) is regarded by the court, not as a sale of cattle, in which guaranty is excluded on account of pregnancy, but as a sale of products. The vendor is obliged to make good the decreased value according to the weight of the pregnant uteri and fetuses, since these parts are not used as food materials.

The Berlin Animal Insurance Society indemnify to the extent of the weight of the pregnant uterus in the case of insured hogs.

VII.

GENERAL PATHOLOGY OF FOOD ANIMALS FROM THE STANDPOINT OF SANITARY POLICE.

The pathological conditions, which can be determined in individual organs of slaughtered animals, may be divided into the following general groups:

(1) Malformations, (2) dissolutions of continuity, (3) atrophy and hypertrophy, (4) deposition of pigment and lime, (5) metaplasiæ, (6) degenerations, (7) circulatory disturbances, (8) transudation, (9) hemorrhages, (10) necrosis, (11) inflammations, (12) simple tumors, (13) infectious granulations, (14) animal parasites.

The sanitary significance of these different forms or abnormalities varies exceedingly. Therefore, for purposes of orientation, it is desirable to explain the principal view-points for judging the conditions which are included under the above-mentioned pathological categories.

1.—Malformations.

Occurrence.—Congenital malformations of the organs of food animals are observed in various forms. The formation of fissures and obstructions are most frequent in the extremities and reproductive organs. Furthermore, fissure formations occur in the internal organs—liver, lungs, spleen—and occasion supernumerary livers, lungs and spleens. Moreover, abnormal accumulations of fluid of a congenital nature are not rare, especially in the liver (fetal hepatic cysts) and in the kidneys (hydrops renum cysticus).

Judgment.—Malformations do not affect the availability of the meat of individual parts of an animal as human food so long as the structure of the tissues remains unchanged; as, for example, in fissure formations. If, however, the histological structure of the tissues is changed, as in congenital renal cysts, the malformed

organ is to be considered as unfit, or highly unfit, for food, according to the degree of the change it has undergone.

2.—Dissolutions of Continuity.

Judgment.—Dissolutions of continuity, in and of themselves, do not lower the quality of any part of the body as a food material. On the other hand, the hemorrhage, which is commonly associated with these conditions, lends the character of spoiled food material to the part which is separated from its natural connections.

Furthermore, dissolutions of continuity must be divided into two essentially different kinds; namely, those which communicate with the outside world (skin, alimentary tract, lungs, urino-genital apparatus), and those which do not communicate with the outside world (rents in the musculature, fractures of bones, with uninjured general integument, ruptures of the heart, liver, spleen, etc.). Wounds which are in connection with the outside world may, by subsequent infection, render the meat unhealthful (see Pyemia and Septicemia), while such a possibility is excluded in the case of lesions which are not in communication with the outside world, and which, therefore, run an aseptic course.

In rendering a decision on dissolutions of continuity, it is very important, in all cases in which the lesions occur immediately before death, to determine whether they are of the one kind or of the other.

3.—Atrophy and Hypertrophy.

(a) Atrophy.

Occurrence.—Atrophy, or wasting away, may affect the whole organism, as in old age, or individual organs. Only the atrophy of glandular organs and of the musculature possesses any sanitary importance. The atrophy of adipose tissue also possesses a diagnostic significance (see "Emaciation").

Judgment.—Atrophied organs are unfit food material, because, as a rule, the specific tissue cells (as, for instance, the liver and muscle cells in atrophy of the liver and muscles) disappear to a greater degree than the interstitial connective tissue. Organs depend for their value upon the specific tissue cells, and must be considered as of less value, or worthless, when the specific cells disappear to a large degree, or entirely.

(b) Hypertrophy.

Judgment.—Hypertrophied organs, in which the histological structure of the tissue is not changed, are considered as equal to normal organs. This condition is most frequently observed as the so-called vicarious hypertrophy in one kidney, while the other is diseased.

4.—Deposition of Pigment and Lime.

(a) Pigmented Deposits.

Occurrence.—An idiopathic pigment deposit, in contrast with symptomatic pigmentation, as in icterus, is frequently observed in cattle in the form of melanosis, or black coloring. It is especially frequent in the lungs, liver, membranes of the brain, and spinal cord. In generalized melanosis, the peritoneum, pleura, fasciæ, vascular structures, nerve sheaths, cartilage and bones are also colored black. Melanosis, as a rule, is congenital, and seems to disappear with increasing age.

Diagnosis.—Melanosis appears in the form of black blotches, or stripes and points. Melanotic organs, therefore, appear to be spotted with black, or "as if sprinkled with India ink." By examining the black colored spots under the microscope, it may be demonstrated that a black pigment (melanin), in granular form, is deposited in the otherwise normal tissue.

Melanosis should not be confused with melano-sarcomatosis (see "Tumors"). The latter, however, may lead secondarily to a melanemia or melanosis of all parts of the body (degeneration of the tumors).

Judgment.—Melanotic organs and parts are unfit for food.

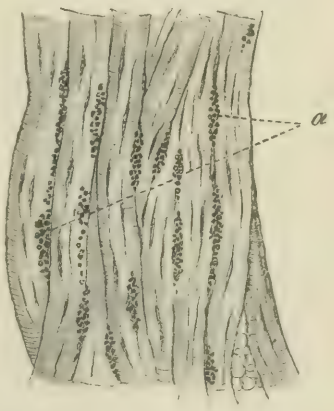
Ochronosis.—Virchow used this term to signify a black coloration of the bones, cartilage and sinews in man. It is not due to melanin, but to another granular pigment. Ochronosis, apparently, occurs also in cattle and hogs, and also, apparently, causes the dark coloration of the heads of the ribs in sucking calves.

Brown coloration of the skeleton.—The Belgian veterinarians, Mosselmann, Hébrant and Wagernous, described a peculiar brown coloration of the bones, which is also occasionally observed in

Germany (the author's observations at the Berlin abattoir, and material sent to the Hygienic Institute of the Berlin Veterinary High School). As a rule, the affection is observed in young cattle, in which all the bones of the skeleton exhibit a reddish-brown, chocolate-brown, or blackish-brown coloration. The chemical analyses made by Mosselmann indicated a normal composition of the bones. The coloring material contained in the bones was not extracted by water, alcohol, ether, or chloroform, but was readily dissolved in alkalies and dilute acids, especially in KOH and HNO_3. In the first case, a brownish-violet solution, and in the second case, a rose-red solution was obtained, both of which were clarified by oxidizing reagents. On heating, ammonia was developed, and, after calcining, an abundant iron deposit remained. Mosselmann, therefore, considered the coloring material as a derivative of hemoglobin, and classified it with the melanins, which, according to Gautier, are insoluble in water, alcohol, and soluble in alkalies and alkaline carbonates.

Judgment.—In a high degree of ochronosis, in which the larger part of the skeleton is affected, and in brown coloration of the skeleton, the decision is the same as in melanosis. A less serious case, in which only certain parts of the bones show a dark coloration, is to be considered as insignificant.

FIG. 43.



Xanthosis of beef musculature (after Goltz). *a*, granular interfibrillar pigment.

Xanthosis.—A liver-brown discoloration of musculature is occasionally observed in cattle. Goltz was the first to call attention to this changed condition. In the cases which Goltz investigated, the heart, muscles of mastication and tongue were most conspicuous for their dark-brown color. The remaining portions of the musculature were simply somewhat darker in color than normal. By a microscopic study, Goltz demonstrated that the peculiar discoloration was caused by the presence of yellow granular pigment between the muscle fibers (Fig. 43). Moreover, the term xanthosis, which Goltz selected, is quite appropriate for designating the cause of the changed color.

When the pigment is deposited between the fibers, it can be recognized only by a magnification of 300 diameters. Goltz found that it gave neither the reaction of iron nor of bile pigment. The pigment can be extracted with chloroform.

Judgment.—If the discoloration is confined simply to the heart, muscles of mastication and tongue, the removal of these parts is sufficient, while the rest of the musculature can be sold without hesitation. For we are dealing with animals which exhibited no functional disturbances before slaughter, and which, even after slaughter, showed no alteration except the peculiar discoloration of the striated musculature.

When the whole skeletal musculature is discolored, the meat is to be considered as unfit for food, and is to be sold only under declaration.

With regard to the black coloration of belly bacon in hogs, compare page 269.

(b) Calcareous Deposits.

Judgment.—A simple calcareous deposit impairs the quality of the organs and parts to a degree proportional to its occurrence; for lime diminishes the percentage content of proteids in animal tissue. The simple calcareous deposit, which is observed most frequently in cartilage, less often in interstitial pulmonary tissue, and in the cortical layer of the kidneys, is of minor importance in meat inspection, as compared with the calcification of parasitic forms (see Calcareous Concretions).

5.—Metaplasiæ.

Virchow distinguishes the direct transformation of one tissue into another by the term metaplasia. Metaplasia occurs only in the tissues of connective structures (connective tissue, fat tissue, cartilage and bone). The transformation of cartilage into bone is most frequent. However, the transformation of the connective tissue castration cicatrix into bone tissue is frequently observed in spayed sows.

6.—Degenerations.

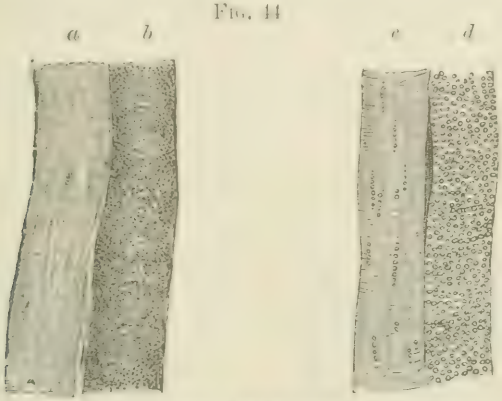
Of the degenerative processes, cloudy swelling and fatty degeneration are of paramount sanitary interest, for the reason

that they are phenomena concomitant with serious general diseases (intoxications and infections). Their recognition is, therefore, of the greatest importance in meat inspection.

(a) Cloudy Swelling.

Cloudy swelling (parenchymatous degeneration, Virchow) is observed only in epithelial structures. The swelling becomes apparent externally by the slight enlargement of the organ, the loss of the original color, sheen, outline and consistency. In the place of the glistening red-brown of the liver, for example, a cloudy grey-brown appears. The outline of the liver is simultaneously obliterated, the consistency becomes friable, and the moisture content

FIG. 44



Cloudy swelling and fatty degeneration of the skeletal musculature. *a*, normal muscle fiber; *b*, cloudy swelling; *c*, slight, and *d*, extensive fatty degeneration.

is diminished. The consistency of the myocardium, when affected with parenchymatous degeneration, may well be compared with that of boiled meat.

Under the microscope, it is observed that the epithelial structures are pervaded with fine, highly refractive granules, or spherules. Consequently, the epithelia appear cloudy and "as if covered with dust." The cell nuclei and the cell walls become indistinguishable. Granules which appear in the epithelia in cloudy swelling consist of albumen.

(b) Fatty Degeneration.

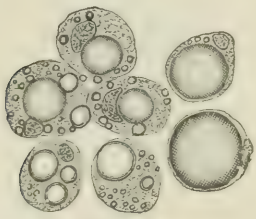
Fatty degeneration (fatty metamorphosis, Virchow) is likewise characterized by a loss of the original color, sheen, outline and consistency of the organs. The color of the liver becomes a cloudy

yellow-brown or grey-yellow. The histological details, which are easily recognized with the naked eye in the normal organ, disappear, and the consistency becomes flabby and soft. Under the microscope an appearance similar to that in cloudy swelling is observed, except that the spherules are fatty instead of albuminous.

Differential diagnosis.—For the differentiation of cloudy swelling from fatty metamorphosis, we add acetic acid to a microscopic preparation. The acetic acid dissolves the proteid globules, while the fat globules remain unchanged. Caustic potash may also be used in making the differentiation. The fat globules in warming become saponified. Lastly, the fat globules in fatty degeneration are colored brown or black by osmic acid, while the proteid globules in cloudy swelling do not give this reaction.

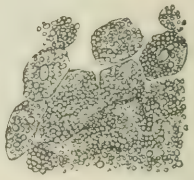
It is, moreover, of great importance to distinguish between fatty degeneration and fatty infiltration. The latter occurs prin-

Fig. 45.



Fatty infiltration of the liver.

Fig. 46.



Fatty metamorphosis of the liver.

cipally in supporting connective tissue, but is also observed in the liver cells and, in excessively fat conditions, even in the renal epithelia and in the primitive fibrillæ of the musculature. The differentiation of fatty infiltration from fatty degeneration is of especial interest in the liver. Fatty infiltration in this organ may appear in the form of sharply outlined spots which extend into the hepatic parenchyma to various depths (McFadyean). As a rule, however, fatty infiltration affects the whole liver. Mild cases are recognizable by a slight yellowish-gray coloration of the peripheral zone of the hepatic lobes; the more extensive the deposit of fat, the smaller is the normally constituted central part, and the greater the swelling of the peripheral part of the lobe as compared with the central part, since fatty infiltration causes an increase in volume of the cells (Kitt). A liver completely infiltrated with fat possesses a

cloudy, yellow-brown color, as in the case of fatty degeneration. The outline of the acini, however, is not obliterated and the consistency is not flabby and soft, but more nearly like that of cocoa butter. Furthermore, in fatty infiltration the liver is enlarged, the borders are rounded, for fatty infiltration signifies the original liver substance plus fat. In fatty degeneration, on the other hand, the liver protein is changed into fat. The organ, therefore, is not enlarged in fatty degeneration, but becomes smaller and comparatively thin, soft and flabby. The borders are not rounded, but sharp.

Under the microscope, the liver cells in fatty infiltration appear distended with large fat globules. The cell membranes and cell nuclei, however, are well preserved, while in fatty degeneration only small fat globules or "fatty abscesses" (Virchow) appear in place of the cells.

In fatty infiltration, according to Perls, the water content of the organ sinks below 50 per cent., while in fatty metamorphosis it remains normal and amounts to from 75 to 78 per cent. The specific gravity of fatty infiltrated organs is also correspondingly less. Normal human livers possess a specific gravity of 1,050 to 1,065 (with a fat content of 3 to 6 per cent.); fatty infiltrated livers, 1,001 to 1,035 (with a fat content of from 15 to 39 per cent.); fatty degenerated livers, as high as 1,056 (with a fat content of from 3 to 8 per cent.); and livers which are both infiltrated and degenerated, 1,009 to 1,012 (with an average fat content of 28 per cent.).

As degenerations of less importance, mention should also be made of the mucoid degeneration of the fatty tissue, in which the latter becomes a yellow transparent mass resembling gelatin, and hyaline degeneration of the muscles, as an indication of serious general disease, or of certain primary affections of the muscle. Hyaline degeneration of the musculature, in which the diseased muscles assume a cloudy, dull, iridescent appearance, like fish meat, is also considered as a necrosis (coagulation necrosis).

Amyloid degeneration is rare in domestic animals. Isolated cases of amyloid degeneration of the liver and kidneys were demonstrated by Rabe in horses and cattle, and by Rivolta, Rabe and Kitt in dogs. In birds, amyloid degeneration appears more frequently. Roll and Friedberger observed amyloid degeneration in pheasants; Kitt in chickens. In an epidemic disease among pheasants, Friedberger found extensive amyloid formations in the liver, spleen, and intestines.

7.—Disturbances of the Circulation.

Local variations in the blood content usually disappear after death by bleeding. They are conspicuous, on the other hand, in case of natural death, and in animals which are killed during the crisis of diseases. A different blood content in paired organs (hypostasis) is, therefore, an important criterion in the recognition of animals which have died a natural death or have been killed during the crisis of disease.

Hemorrhagic infarcts arise through embolic obstruction of the terminal branches of the arteries. They possess a round or wedge form and are first red, then yellow, and finally white in color. Embolic infarcts are of importance in meat inspection only when they are infected and consequently exhibit softening (see Pyemia).

8.—Transudation.

Transudation appears either in the form of edema, inside the tissue, or of hydrops in the body cavities. Both edema and hydrops occur in consequence of certain disturbances of the circulation, or of hydremia.

Judgment.—Edematous infiltrated organs are to be treated as unfit for food. Dropsy of the body cavities, on the other hand, has no sanitary significance.

9.—Hemorrhages.

By the term hemorrhage is understood an escape of the blood *in toto* from the tissues. Distinction is made between slight, limited hemorrhages (petechiæ or ecchymoses) or more extended and diffuse hemorrhages (suggilation). Petechiæ may occur in all organs. They are usually located in the serous and mucous membranes; also in the cutis and subcutis. Like the parenchymatous and fatty degenerations, they are an important concomitant symptom of intoxications and infectious diseases, and are to be given special consideration in the determination of septic diseases. Suggilations, as a rule, are sequelæ of mechanical rupture of the connections between tissues. Hemorrhagic infiltration of the musculature is very frequent in consequence of bone fractures.

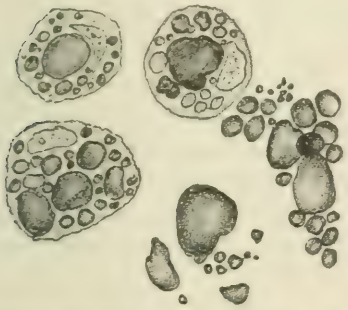
In the determination of the latter condition in slaughtered animals, it should be noted that slight hemorrhages on the external

surface of animals which have been skinned should lead one to make incisions, since the connective-tissue strands are usually infiltrated as far as the subcutis in case of extensive, deep hemorrhages (Fischöder).

Judging bloody parts.—Bloody meat is an inferior food material. Butchers attempt to remove the blood-coloring matter by sprinkling with salt, subsequent washing with water, and the application of pressure to the pieces of meat. This is successful in the outer layers, but not in the deeper portions.

Determination of the length of time since the occurrence of hemorrhages.—Experts in meat inspection are frequently called

Fig. 47.



Hemosiderin, partly in nucleated cells, partly free in the tissue. X 1,000 diameters (Thoma).

Fig. 48.

Hematoidin crystals, from a large, centrally softened blood extravasation of the peritoneal cavity. X 250 diameters (Thoma).

upon to render an opinion as to the age of hemorrhages, when they are so extensive that the meat is considerably depreciated in value. According to Dürck, in determining the age of hemorrhages, we may make use of the changes which occur in the red-blood corpuscles, and the red-blood coloring material in extravasations. Dürck made his determinations in hemorrhages artificially produced in the brain, and observed, in the first place, leaching and swelling of the red-blood corpuscles. The first change is manifested from the second day by etiolation, to the extent of complete transparency. The swelling becomes manifest when the flat, biconcave corpuscles gradually become spherical. From the fifth day a shrinking begins, which is ushered in by the appearance of minute impressions in the periphery of the blood corpuscles. One portion of the colorless

stroma may remain in this condition for sixty days or more. In another part, however, shrinking is more extensive; and then in from six to eight days, either irregular polygonal and stellate or scutellate and cup-shaped forms are observed. Concomitantly, a certain comparatively small number of red-blood corpuscles are surrounded by contractile cells from the third day on.

Up to the sixth day, hemoglobin penetrates uniformly the surrounding tissue, and gives it a light-brown color. Towards the end of the sixth and beginning of the seventh day, a modification of the red-blood coloring matter occurs, which has been described by Neumann as "hemosiderin." The hemosiderin at first penetrates the whole tissue in a diffuse manner (extensive Berlin-blue coloration after application of iron reaction). After the tenth day, it is restricted more and more to the contractile cells, and after the twelfth day is found exclusively in them. After twelve days the pigment, previously dissolved in the plasma of the white-blood corpuscles, becomes granular. The granulations are at first hard, but disintegrate into finer and finer granules from the eighteenth to the twenty-fifth day. Simultaneously, the cells which inclose the granules disintegrate so that the first free pigment granules are seen in the tissue after the eighteenth day. Toward the sixtieth day, one finds in the tissues only a rather finely granular pigment, free from iron. Furthermore, pigment crystals may be formed under certain conditions not clearly understood.

10.—Necrosis.

Necrosis may appear in all the tissues. It has significance in meat inspection, however, only in those parts of the animal body which are in direct contact with the outside world; for the bacteria of decomposition, which are always present in atmospheric air, may settle upon necrotic tissues and cause pathological changes (see Sapremia). Furthermore, necrotic tissues do not offer protection against pathogenic bacteria, as does living tissue, for the reason that the former may be penetrated by pathogenic micro-organisms. Among the pathogenic bacteria, those which cause inflammation and suppuration have a ubiquitous distribution, similar to the bacteria of decomposition. Consequently, with necrosis of the skin, stomach wall, intestinal wall, uterus, etc., there is regularly associated an inflammatory condition of the neighboring tissue, and, under certain circumstances, also pyemia and septicemia.

11.—Inflammations.

Inflammatory processes in the animal body must, from the standpoint of meat inspection, be judged according to their kind and degree as well as according to the affected organ. We distinguish productive, serous, purulent, croupous, diphtheritic, hemorrhagic and putrid inflammations. These forms of inflammation may occur either on the surface of the skin, mucous or serous membranes, or in the interior of the tissues. Superficial inflammations of the mucous membranes are characterized as catarrh, and a distinction is made again between desquamative, serous, mucous and suppurative catarrh, and mixed forms. In inflammations of tissue, in so far as glandular organs are concerned, distinction is made between parenchymatous and interstitial inflammation, according as the specific glandular substance or the supporting tissue is diseased.

The deciding factor for the sanitary judgment of inflammations is their etiology. Most inflammations are produced by bacteria. We recognize, however, inflammations which are caused by mechanical irritation, such as productive inflammations on the serous membranes, and verminous pneumonia; also inflammations caused by thermic irritation (scalds, influence of the sun's rays, or excessive cold); and by chemical irritation (caustic and drastic reagents).

All inflammations which arise in consequence of physical or chemical irritation possess, in and of themselves, only a slight significance in meat inspection, for they are local, and heal after the disappearance of the irritation. Inflammations which are caused by bacteria, on the other hand, may give rise to general diseases, and may give a worthless or unhealthful character, not only to the affected organs, but also to all other parts of the body. It is to be remembered, moreover, that secondary infectious processes may develop in lesions which arise from physical or chemical irritations.

The following details are given with reference to the different forms of inflammation:

(a) Productive Inflammations.

Nature.—By the term productive inflammation, we understand inflammations which are accompanied with the formation of new tissue. Of special interest for meat inspectors are the new formations of connective tissue in the interstitial tissues of glandular

organs, and in the connective-tissue substratum of serous membranes under the influence of moderate but continuous irritation (cirrhosis of the liver, interstitial nephritis, pleuritis, perihepatitis, peritonitis fibrosa, etc.).

Judgment.—Productive inflammations possess merely a local significance. In a mild form they are insignificant. Excessive interstitial inflammation, however, may render organs unfit, or highly unfit, for food, for it is accompanied by the destruction of those elements which give the organs in question their character and value as food material.

(b) Serous Inflammation.

Occurrence.—This occurs either as inflammatory edema in the tissues, or as inflammation of the serous membranes, with a thin, slightly clouded exudate. Inflammatory edema may be caused by the bacteria of suppuration, and also by other micro-organisms (see "Pyemia" and "Malignant Edema"). Serous inflammation of the lining membranes of the body cavity is either a phenomenon concomitant with the inflammatory process in organs in the cavities in question (for example, pleuritis as a sequela to pneumonia), and, therefore, without primary significance, or a primary infection, to be judged by itself.

Judgment.—The decision with regard to primary serous inflammation varies. In case of a serous inflammation in closed cavities which do not communicate with the outside world (as, for example, in non-traumatic meningitis, tendo-vaginitis and arthritis of domestic animals), the process, according to previous experience, remains localized in the affected organ. In case of a previous wound, however, it is necessary to determine whether the inflammation possesses a septic character (see "Septicemia").

Serous, as well as sero-mucous, catarrhs are local affections which, at most, may destroy the character of the mucous membranes, in so far as these are concerned as food material.

The exudation in traumatic serous inflammation of the lining membranes of the body cavity frequently shows, in the same manner as in secondary pleuritis, an admixture of fibrin in the form of yellow flakes or plates, which become attached to the surface of the serous membranes, and may easily be removed from them (sero-fibrinous inflammation).

(c) Purulent Inflammation.

Course.—Purulent inflammation, as a rule, runs a local course. Exceptionally, it may become generalized.

Judgment.—An organ containing pus pockets is to be regarded as an unwholesome food material; likewise, the meat of animals which have suffered from generalized suppurative processes. For further details, see under "Pyemia."

(d) Croupous and Diphtheritic Inflammation.

Diagnosis.—It should first be stated that, anatomically, both these forms of inflammation occur only on mucous membranes. They are essentially distinct from one another. In croupous inflammation, a coagulable exudation is deposited on the surface, and the epithelium disappears. In diphtheritic inflammation, on the other hand, a fibrinous exudation is formed in the mucous membrane itself with the necrosis of the latter. The croupous exudation, from the manner of its origin, may be removed from its substratum without destroying the tissue deeper than the epithelium, while the diphtheritic exudation is firmly united with its substratum, and, after being thrown off, naturally leaves a deeper scar, or ulcer.

Occurrence and judgment.—Croupous and diphtheritic inflammations are most frequently observed in man in the form of the disease known as diphtheria. We know of no disease of domestic animals which is identical with this affection of man. Croupous and diphtheritic inflammations, however, are frequently observed in cattle. In this animal, diphtheritic and croupous inflammation accompany, chiefly, two infectious diseases: Rinderpest and malignant catarrhal fever. Furthermore, a diphtheritic inflammation may occur in the uterus, and it forms here a process which is to be judged very cautiously, whether before or after death (see "Septicemia"). In the case of rinderpest and malignant catarrhal fever, on the other hand, nothing is known concerning the injurious effects of eating the meat of animals which have suffered from these diseases.

Finally, mention should be made of diphtheritic inflammation of the mucous membrane of the urinary passages, which is caused by decomposition of the urine within the efferent urinary ducts. This diphtheritic inflammation is also to be judged favorably with regard

to the availability of the meat for food, since, according to all our experience, it does not produce injurious effects upon the health of those consuming it (compare "Pyelo-nephritis").

(e) Hemorrhagic Inflammation.

Nature.—In hemorrhagic inflammation, there is an admixture of numerous red blood corpuscles to the exudation (red coloration). Hemorrhagic inflammation is to be considered a symptom of a very severe irritation (great alteration of the capillary walls). It readily leads to necrosis.

Judgment.—The etiology of hemorrhagic inflammation is not simple. Consequently, general propositions for the sanitary judg ment of hemorrhagic inflammation can not be laid down. We merely know from experience that the meat is harmless in a large class of diseases which are commonly accompanied with hemorrhagic inflammation, as in pneumonia of horses (hemorrhagic pneumonia), in hemorrhagic septicemia (hemorrhagic enteritis), in swine erysipelas (hemorrhagic enteritis, nephritis, lymphadenitis), and in urticaria of hogs (hemorrhagic dermatitis). In other diseases, however, such as petechial fever in horses, and certain not well understood forms of hemorrhagic inflammation of the intestines in cattle, the meat has produced harmful effects (see "Septicemia" and "Meat Intoxication").

(f) Inflammations with Putrid Exudations.

These inflammations arise in consequence of the presence of putrefactive bacteria in the products of serous, suppurative, or necrotic inflammations. For further details on this subject, see "Sapremia" and "Septicemia."

(g) Parenchymatous and Interstitial Inflammations.

These inflammations take their names from their different positions in glandular organs. Parenchymatous inflammations affect the epithelial elements; interstitial inflammations, on the other hand, affect the supporting tissue. Interstitial inflammation is, as a rule, productive.

Judgment.—Parenchymatous inflammations are to be judged according to their causes. As a rule, however, parenchymatous inflammations are symptoms of certain intoxications and infections, and possess, therefore, only a diagnostic significance. The judgment

of interstitial inflammations corresponds to that of productive inflammations.

12.—Tumors.

Tumors are classified, clinically and pathologico-anatomically, as benign and malignant.

(a) Benign Tumors.

Benign tumors, in their sanitary relationship, possess only a minor importance as strictly local affections. Organs which are affected with benign tumors may be put in a marketable condition by removal of the neoplasm, since benign tumors do not alter the internal character of the organs except in their immediate neighborhood.

(b) Malignant Tumors.

Malignant tumors, sarcoma and carcinoma, have a decided tendency to enlarge at the expense of the affected organs. They displace the normal tissue by their rapid local growth, or penetrate it diffusely (infiltration), and, in addition, form metastases in other organs.

Occurrence.—Malignant neoplasms occur primarily in all the vital organs and upon the general integument. Sarcomata, moreover, may occur in the skeleton. According to Pouchet and Metz, the scapular cartilage is characterized as the usual location for the melano-sarcomata, which occur so frequently in white horses. During the process of metastasis, sarcomata and carcinomata may become spread throughout all parts of the animal body. In the latter case, we speak of generalized sarcomatosis or carcinomatosis.

Diagnosis.—The recognition and differentiation of malignant tumors belong to the rudiments of general pathology, and may, therefore, be omitted here. It should be simply noted that sarcomata in the lymphatic glands are distinguished from tubercular alterations by the fact that sarcomata permeate the lymph glands in the form of a tubercle, or in a diffuse manner, and show caseation, but no calcification; while the presence of small tubercles, which regularly become casefied in the center, and later become calcified, is characteristic of tuberculosis.

Judgment.—According to the present status of our knowledge, we must consider meat, or individual organs, which inclose malignant tumors, as a spoiled food material. Despite the fact that sarcomata and carcinomata occur in man, such meat is not dangerous to health, for the reason that, according to all experiments, the transmission of these tumors by means of the digestive apparatus is impossible. Among hundreds of experiments which have already been made, it has only been possible, in a few isolated cases, to transmit cancer from animal to animal by intraperitoneal injection (Wehr, Hanau, *et al.*), and to inoculate with fibro-sarcomata (Eiselsberg). The conditions surrounding these cases must have been peculiar, for the investigators succeeded only once in transmitting the disease. Furthermore, the possibility of intraperitoneal transmission proves nothing with regard to the transmissibility of the disease through the alimentary tract.

If malignant neomorphs are confined merely to individual parts of an organ, or of the meat—for example, to certain bones (osteo-sarcoma), or to lymph glands (lympho-sarcomatosis)—the meat may be offered for sale after careful removal of the diseased parts. If the meat is otherwise unchanged, there is no reason for prohibiting its sale.

In cases in which the whole musculature, all the bones and intermuscular lymph glands are permeated with metastases, the sale of the meat must be absolutely prohibited as highly unfit for food. A similar course should be adopted in the case of organs which show a few large, or numerous small, malignant tumors.

Formerly, as stated by Grams, a common and fundamental mistake was made in judging metastatic formations of malignant tumors. They were placed upon the same basis with the generalization of infectious processes: for example, tuberculosis; and the generalization of the tumors was considered as already present, if the appearance of wide distribution was seen merely in the entrails. This point of view is not justified, since the tubercle bacilli, which are carried in the circulation, can not be readily demonstrated as such in the musculature. In the vital organs, however, they produce such striking changes as to furnish valuable diagnostic aid in the determination of generalization. In malignant tumors, on the other hand, in the case of generalization, we have to do with the transportation of tissue elements which develop rapidly, and upon dissection of animals may be easily found in the musculature, and especially in the intermuscular lymph glands.

13.—Infectious Granulations.

Infectious granulations are caused by specific plant organisms. To the infectious tumors of domestic animals belong also the neomorphs of glanders, tuberculosis, actinomycosis and botryomycosis. For further details, see "Infectious Diseases."

14.—Animal Parasites.

The number of animal parasites in domestic animals is exceedingly large. Only a few organs are entirely free from them. The others are so regularly infested with worms that their presence may be considered as almost a normal condition; as, for example, the presence of fluke worms in the liver of sheep and cattle, and of Strongylidæ in the lungs of the hog.

Some of these parasites are harmless guests, while others produce extensive changes in the affected parts, and, under certain conditions, may cause a more or less serious disturbance of the general health.

By far the greater number of the parasites of domestic animals are harmless for man. Domestic animals, however, harbor dangerous enemies of man, particularly trichinæ and cysticerci (compare the chapter on invasion diseases).

VIII.

ESPECIALLY NOTEWORTHY ORGANIC DISEASES.

It is not in the province of a text-book on meat inspection to discuss in detail all organic diseases. We have all the more reason for omitting such a detailed consideration here, since the principles of sanitary judgment of the different pathological processes in general are mentioned in the discussion of general pathology (Chapter VII). In the following discussion, therefore, only those organic diseases will be mentioned which are of special interest in any particular way (variation from the typical structure, or of value in differential diagnosis). Parasites and infectious granulations will be mentioned only incidentally, for the reason that a comparative and exhaustive presentation of those subjects is given under general diseases.

1.—General Integument.

(a) Cutis.

Solutions of Continuity.—As a rule, skin wounds heal rapidly. They offer favorable conditions for infection only until granulation begins. For granulations are centrifugal processes; they furnish a mechanical protection against the penetration and resorption of foreign material. Granulating wounds are, therefore, to be looked upon as unimportant alterations, provided that the granulations extend uniformly over the surface of the wound, and communication between the deeper-lying parts and the outside world is not interrupted by the granulations. In the latter case, it is necessary to determine whether a retention of the secretion and its possible sequelæ are present.

Erythrisms.—Erythrisms of the cutis may be due to hemorrhages, inflammation, or hypostases (death marks). Active hyperemia of the skin disappears completely after death. The differentiation of the first-named three kinds of erythrism offers no difficulty.

In hemorrhages, blood or blood corpuscles are found in the interstices of the tissue. They occasion no conspicuous swelling, and can not be removed by pressure with the finger. In inflammation there are accumulations of blood in the capillaries, and a swelling arises with exudation. Death marks are found only in the deeper lying parts of the body. They are bluish-red, and readily disappear on pressure with the finger, since the blood is in the capillaries, and capillary blood does not coagulate. It is only where imbibition has already begun that the erythrism can not be made to disappear on pressure. As the name signifies, death marks are a sign of death, and, in fact, of natural death. In connection with them, there is simultaneously a large blood content of the subcutis (Klein).

In differential diagnosis the erythrisms of the skin of the hog are especially important (see "Swine Erysipelas").

Other Alterations.—In inspecting calves, attention should be given to the condition of the skin in the region of the navel (inflammatory alterations in connection with umbilical infection). In the hog, the following alterations of the skin deserve special mention: Thickening of the connective tissue frame-work of the cutis into a cartilage-like condition in boars (compare page 167); black pigmentation of the cutis and of the panniculus adiposus on the ventral side; sooty mange of young pigs; and the so-called granular eruption.

Black pigmentation of belly bacon.—Female, male and castrated hogs, especially if they are black haired, occasionally possess in the panniculus adiposus, in the under part of the abdomen, numerous black, irregular, dendritically or venously branched spots, which were described by Saake in 1878, and recently by de Jong. According to de Jong, the spots are due to pigment deposits which are distributed in masses, and have their seat in the connective-tissue trabeculæ of the supporting substance of fat tissue, and not in the fat cells. The pigment is granular, and under slight magnification shows black, blackish-brown, brown, reddish or red coloration. It is insoluble in hot water, alcohol, ether, chloroform and bisulphid of carbon, and is not changed by sulphuric acid. De Jong could not obtain an iron reaction. This, however, does not militate against the opinion entertained by the author, that the black pigmentation of belly bacon is a consequence of hemorrhage, since the remainder of the hemorrhage loses its iron after a certain time (see page 259). In favor of the hematogenous origin of the

pigment in question, we have the seat of the pigment (frequent liability of bruising), and the fact, which was demonstrated by Blanc, that the pigment accumulates, especially in the region of the blood vessels.

It should be noted that Türcks observed black pigmentation of belly bacon in six black hogs which came from the same sty.

Judgment.—The abnormal color makes belly bacon affected with this pigment unfit for food, and it should be sold only under declaration.

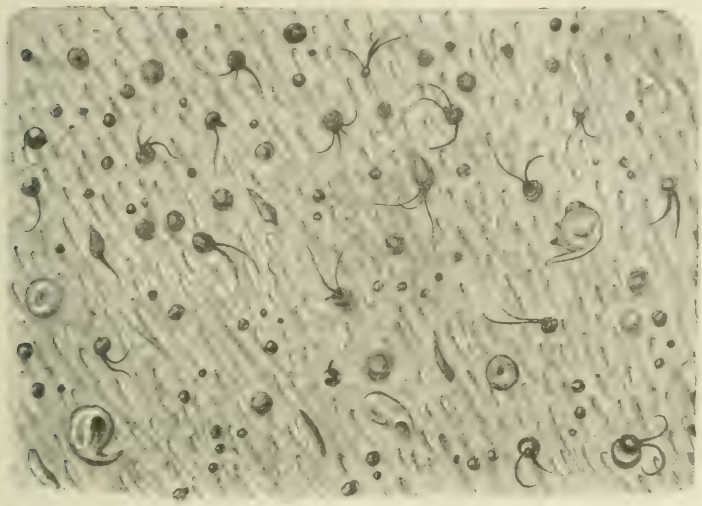
Sooty mange of young pigs.—By this term is understood a scab-like eczema of acute or chronic form in young hogs. In sooty mange an eruption of vesicles is observed, which are filled with pus, and burst. In this way a dark, pitchy scab is formed (pitchy mange). Sooty mange is merely a symptom of internal disease. The nature of the latter determines the course of action with regard to the meat of hogs which are affected with sooty mange.

Granular eruption (Zschokke).—Granular eruption is characterized by the presence in the cutis of roundish tubercles of various colors, and varying in size from that of hemp seed to that of peas (Fig. 49). The tubercles are firm but yielding. Curled hairs are to be seen through the apices of the tubercles. The hairs lie in a dark, oleaceous, tallow-like mass. The grain-like or shot-like tubercles, from which Zschokke named the disease, are especially numerous in the cutis of the croup, sides of the breast, and ears. Opinions are divided on the nature of the disease. Kitt considers the tubercles as atheromata of a minute size. Johne and the author consider them as multiple dermoid cysts, and Lungershausen, as arrested development (hypotrichosis). Finally, Zschokke expressed the opinion that granular eruption represents an infectious process (conical proliferation of the epidermis inwardly, in consequence of an infection by micrococci).

According to the careful investigations of Olt, none of these explanations is satisfactory. Olt demonstrated, in the first place, that granular eruption is a skin disease of progressive character; that the diseased parts of the skin are sharply delimited, and exhibit large cysts in the middle and smaller ones at the periphery. Recently formed tubercles, recognizable by the naked eye, are of minute size, pale-yellow, or often almost white. By further growth in a superficial position, the tubercles acquire the sheen of dull

pearls. Later, they become russet-red, yellowish-brown to brown, and finally blue-black, with a metallic luster. The largest vesicles

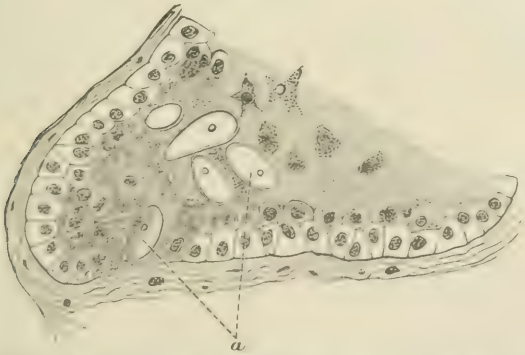
FIG. 49.



Granular eruption of the hog after removal of the normal bristles. In some of the tubercles coiled and protruding bristles are seen.

are of the size of mustard seeds, or, rarely, as large as peas. The vesicles are filled with a cloudy, watery fluid, and usually contain

FIG. 50.



Granular eruption of the hog. Cross-section of a convoluted gland (after Olt). *a*, coccidia surrounded with shells and lying between the disintegrated epithelia.

one, or, according to circumstances, two or three, rarely more, bristles. Furthermore, Olt discovered from serial sections that the pathological process arises in the sweat glands, and is caused by

coccidia, which are parasitic in the epithelia of the sweat glands, and cause a proliferation of the epithelial layer (*spiradenitis coccidiosa*). The epithelial proliferation leads to inhibition of the secretion and to the formation of a cyst. The bristles come to lie in the cysts, either through fusion of the hair follicles with the cysts, or by penetration of developing bristles into the primary cysts of the convoluted glands. The fully developed coccidia have a membrane, are ovate, .034 mm. long, .0275 mm. wide, and, therefore, somewhat thicker than *Coccidium oviforme* (Fig. 50). They are distinguished by their brown color, wherefore Olt gave them the name, *Coccidium fuscum*. The youngest forms are naked, and are found in the epithelia as brown, granulated masses of protoplasm. Later, by the destruction of the epithelial cells, the young forms become free, and wander into the interior of the glands, and transform themselves in the contents of the glands with different transition stages into forms surrounded by membranes.

Judgment.—Granular eruption is a harmless local affection of the skin, which requires merely the removal of the diseased parts of the skin before sale.

Finally, in the study of the skin the following diseases are to be considered :

(a) In the horse, hemorrhages in petechial fever (morbus maculosus), sarcomata, melano-sarcomata in white horses ; botryomycomata ; glanderous tubercles, glanderous ulcers, as well as sarcoptic and dermacoptic mange (the latter merely in relation to veterinary police).

(b) In cattle, actinomycosis, aphtha, and their sequelæ.

(c) In sheep, scab.

(d) In the hog, aphtha and bleeding erosions, especially in the hoof.

In birds, especially chickens, turkeys and pigeons, there is observed an infectious alteration of the skin (contagious epithelioma.)

(b) Subcutis.

Subcutaneous Fat Tissue.—The subcutis connective tissue is one of the most important depositories of fat. Consequently, in fattened animals, it is transformed into a strongly developed tissue. In emaciated animals, on the contrary, a yellow serous infiltrated connective tissue is found in the place of the fat tissue.

Edema.—In the subcutis of the lower-lying regions of the body are observed the first consequences of serious hydræmia, as well as

of heart disease (endocarditis and pericarditis), in the form of extensive transudations (anasarca). Moreover, in the subcutis of cattle, restricted edema may be developed around the larvæ of œstrus.

Urinous Infiltration and Phlegmon.—Urinous infiltration and phlegmon are essentially different from edema. Urinous infiltration arises from lesions of the urinary ducts. It is to be recognized by the urinous odor of the infiltrate and the tendency of the infiltrated parts to necrosis. Phlegmon is a serous, purulent or hemorrhagic inflammation of the subcutis, which, in limited extension, has no sanitary significance. It is quite otherwise with malignant edema and black leg (see these subjects).

Other Alterations.—In addition to the above-mentioned alterations, we may have in the subcutis tuberculous actinomycomata, botryomycotic alterations, also blood effusions (simple and specific [anthrax, morbus maculosis]) and emphysema of mechanical origin.

In the subcutis and intermuscular tissue of fowls, mites (*Cytodites nudus* and *Laminosioptes cysticola*) are frequently found. They either live in a free condition, or are located in simple connective-tissue capsules of only ½ to 1 mm. in diameter, which possess a flattened form and are frequently incrusted with lime salts.

Judgment.—The number of mites in the connective tissue may be so great that the meat must be considered as highly unfit for food. A few specimens of the mites are to be considered as unimportant, in view of the frequency of their occurrence. In infestation of medium extent, the sale of the meat may be permitted under declaration as an inferior food material.

2.—Digestive Apparatus.

(a) Mucous Membrane of the Mouth and Tongue.

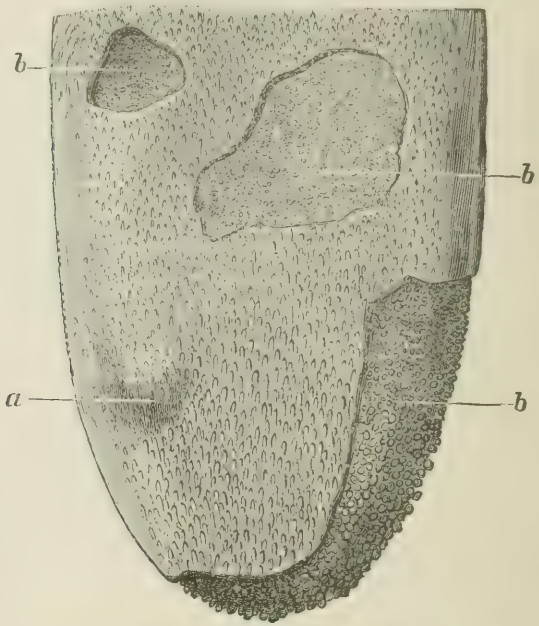
Inflammation and infectious granulations occur most frequently on the mucous membrane of the mouth and tongue of food animals.

Inflammations.—The inflammations of the mucous membrane of the mouth cavity and tongue, as well as inflammations of the anterior parts of the alimentary tract, are of interest on account of their varying etiology. As a rule, they are caused:

1. By traumata or caustic materials, which are administered to the animals as medicines, or are ingested by them with their food.

2. By specific toxines (aphtha, Fig. 51; rinderpest, scurvy, and diphtheria of calves and of fowls). Moreover, an ulcerous stomatitis appears as a general phenomenon in metal poisoning, especially in mercurial poisoning. In so-called diphtheria of calves and fowls, croupous and diphtheritic inflammations on the mucous membrane of the mouth and pharynx form the most important symptom of the disease (see these diseases). In rinderpest, large edematous swellings of the tongue are observed. The tongue may

FIG. 51.



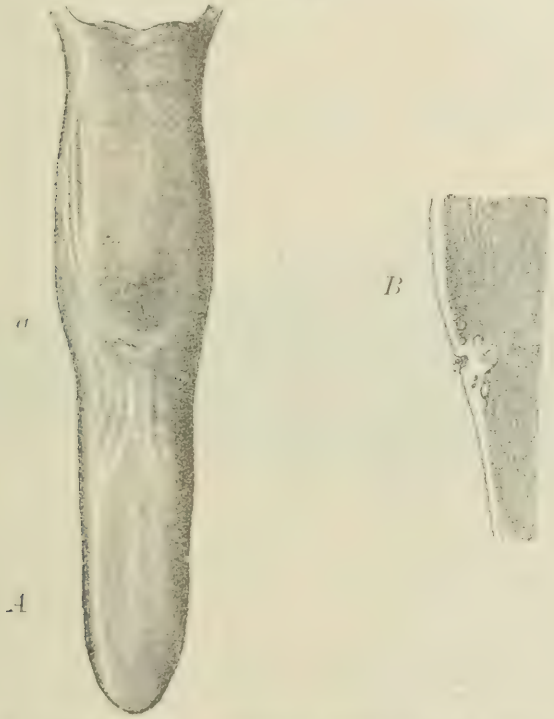
Aphtha. Tip of beef tongue.
a, Aphtha; *b*, epithelial erosion after bursting of the aphtha.

be enlarged to three or four times its natural size. Furthermore, a considerable enlargement and prolapsus of the tongue may occur in consequence of phlegmonous stomatitis.

Judgment.—In caustic irritation of the anterior part of the alimentary tract, if death does not follow at once, it is necessary to determine if secondary processes have arisen from the corroded or necrotic parts of the mucous membrane; for it is only such secondary processes, and not the poisoning itself, which renders the meat dangerous. The other inflammations of the oral cavity are without independent significance (for judgment, see under the different diseases in question).

Actinomycosis.—In cattle, the mucous membrane of the mouth cavity and organs lying in it are frequently the seat of actinomycotic alterations. They appear either as superficial erosions, resembling lesions of the mucous membrane, or in the form of granules and tubercles in and upon the mucous membrane. Superficial foci may be confused with the sequelæ of aphtha. The former are distinguished from the latter by the fact that the floor of the ulcers,

Fig. 52.



A, Beef tongue with typical actinomycotic affection (*a*); *B*, section through the primary focus (after Henschel and Falk).

which feels leathery, is sprinkled with minute yellow spots; the fungiform papillæ are destroyed (Leutsch); and also by the fact that the destruction of the epithelium is not so sharply delimited from the erosions as in the case of broken aphthous pustules (compare Figs. 53, *a*, and 51, *b*). According to Henschel and Falk, the dorsal surface of the tongue at the transition point, between the body of the tongue and the tip, is the most frequent location of primary actinomycotic affections (Fig. 52, *A*, *a*).

Henschel and Falk called attention to the point that in many cattle (90 out of 985 inspected, or 9.1 per cent.), epithelial lesions occur at the point above described. In the majority of cases these lesions represent an incipient actinomycotic infection (in the 985 animals above mentioned, this was the case in 71, or 7.2 per cent.). According to Breuer, the frequency of primary lingual actinomycosis at the transition point between the body and tip of the tongue varied in cases observed in Budapest between 16 per cent. in summer and 33 per cent. in winter. Schwaimair observed this alteration in 26 per cent. of the Bavarian cattle which he examined. When an incision is made in the spot where the epithelium is wanting, one generally finds small tubercles or small abscesses which contain actinomyces. Comparatively few of these foci are simple

FIG. 53.

Beef tongue with (*a*) actinomycotic erosions; *b*, mushroom-shaped actinomycomata. The tip of the tongue also exhibits the condition of wooden tongue.

abscesses produced by pyogenic bacteria. In the foci in question on the tongue, one frequently finds small foreign bodies, grains, which are strongly penetrated with actinomyces. Henschel and Falk ascribe the above-mentioned typical lingual affection of cattle to their peculiar mode of ingestion (retention of fungus-covered portions of food at the boundary between the moveable and fixed portions of the tongue.

Breuer, on the other hand, considers it probable that the disease is associated with a peculiarity of the structure of the tongue. In cattle a crescent-shaped atrophy of the mucous membrane occurs in front of the dorsal ridge of the tongue, with destruction of the filiform papillæ. The smooth portion of the mucous membrane thereby becomes more easily injured than the other portions of the lingual mucous membrane. In accordance with this

explanation is the fact, established by Breuer, that the frequency of the disease in question increases with the age of the cattle.

Tubercular actinomycomata may occur upon the mucous membrane of the whole anterior portion of the digestive apparatus of cattle, from the lips to the fourth stomach. The tongue and mucous membrane of the mouth and pharynx are most frequently affected; more rarely that of the first three stomachs. Actinomycomata ordinarily sit upon the mucous membrane like mushrooms or conical or flat proliferations. The colonies of actinomyces upon their surfaces are readily distinguished from the red ground color as yellow spots (Fig. 53, *b*).

Johne has called attention to the ray fungus in the tonsils of hogs. Occasionally actinomycosis is also observed in the retropharyngeal lymphatic glands of cattle.

Actinomycosis of the tongue is characterized by distinct anatomical forms. As already described, it may occur as a superficial process in the form of erosions. Furthermore, the disease may appear in two other forms: In the form of multiple tubercles of various sizes which lie scattered in the tissue of the tongue, and as diffuse induration of the tongue (wooden tongue).

The tubercles may be readily detected by touch, especially while the animal heat is still present. Moreover, upon microscopic inspection, they exhibit the typical structure of actinomycotic granulations.

Wooden tongue, which is very frequent in cattle and has been observed once in sheep (Berg) and hogs (Schilling), is distinguished by its firm, unyielding consistency. On cross section, one observes a vigorous proliferation of connective tissue and an atrophy of the musculature of the tongue. The connective tissue proliferations include small and large colonies of the ray fungus. As a rule, wooden tongue is a partial alteration. A complete induration of the tongue rarely occurs, since animals affected with wooden tongue are soon slaughtered on account of the difficulty they experience in the prehension of food.

Non-actinomycotic wooden tongue.—Pflug described several cases of non-actinomycotic wooden tongue. The tongues were hard, enlarged, white on cross section, and without a trace of muscular tissue (diffuse interstitial myositis). Later, Imminger reported similar cases. Furthermore, Kitt observed a fibroma of the tongue, which had likewise led to the formation of the so-called wooden tongue.

Tuberculosis.—Tuberculosis is frequently met with as a primary affection in the lymph glands of the head (retro-pharyngeal glands in cattle ; tracheal lymph glands in hogs). Simultaneously a tuberculous alteration of the tonsils may exist.

Morot claims to have frequently observed tuberculosis of the tongue. This assertion does not agree with observations in German slaughter-houses. In Germany, tuberculosis of the tongue is an exceptionally rare occurrence. In Berlin, for example, only one case of tubercular disease of the tongue was established during ten years.

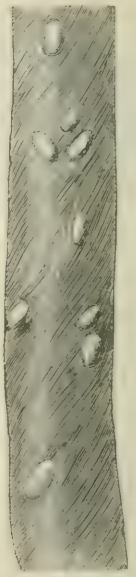
(b) Pharynx.

Besides typical pharyngitis, the sanitary significance of which varies according to the degree of inflammation and the accompany-

Fig. 54.

Bovine œsophagus with œstrus larvæ. On the right a larva in natural size.

Fig. 55.



Sheep œsophagus with sarcosporidia.

ing phenomena, specific changes occur in the mucous membrane of the pharynx in the form of hemorrhages, bloody serous and pure serous infiltrates, in petechial fever, anthrax, hemorrhagic septicemia, and swine erysipelas. Furthermore, the larvæ of *Gastrophilus* are frequently found in the pharynx of the horse.

In the pharynx of the stag the larvæ of *Pharyngomyia picta* and *Cephenomyia rufibarbis*; in the roebuck, the larvæ of *C. stimulator*; and in the reindeer, the larvæ of *C. trompe*, are found.

(c) Esophagus.

In the mucous membrane of the esophagus of cattle one observes papillomata; in cattle and sheep, the esophageal thread worm, *Filaria scutata esophagea bovis*; and, finally, in the musculature of the esophagus of cattle, the larvæ of *Oestrus bovis* (Fig. 54); and in the same location in sheep, goats and horses, one finds *sarcosporidia* (Fig. 55).

(d) Stomach and Intestine.

The most important abnormal conditions of the stomach and intestines are inflammations and parasites.

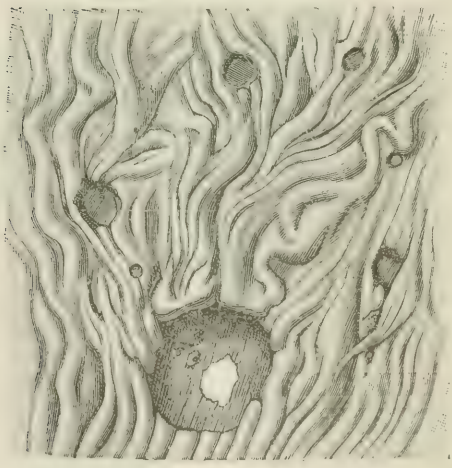
Inflammations.—Inflammatory alterations may be of different sorts. All transition stages are observed from simple catarrh accompanied simply with erythrism and swelling of the mucous membrane, to diphtheritic inflammation ushered in with necrosis of the mucous membrane. The judgment on this process should vary accordingly, as already stated in the chapter on general pathology. One point, however, ought to be again emphasized in this place: Simple gastric catarrhs, as well as simple non-febrile enteric catarrhs, are without sanitary significance. It is necessary, however, to differentiate between these harmless diseases and septic diseases of the intestines of calves and cows, ushered in with high fever and great depression (see under "Diarrhea," "Emergency Slaughter" and "Meat Poisoning"). Schwaimair, by a regular inspection of the second stomach of slaughtered cattle, demonstrated that traumatic inflammation of this organ is much more frequent than commonly supposed. Of 639 cattle inspected, 54, or 8.62 per cent., were affected with inflammation in consequence of injury by foreign bodies. The majority of the animals had exhibited no disturbance of health during life.

Harms described a phlegmonous gastro-enteritis in cattle, which, as a rule, ran a fatal course. The mucous, muscular and serous coats were inflamed. A bloody content was occasionally found in the small intestines. Harms emphasized the fact that the meat of animals which were affected even with an advanced stage of phlegmonous gastro-enteritis did not show the slightest variation from the normal condition. In the case of cattle which were well

nourished and seasonably slaughtered, Harms accepted the meat as fit for human food when it was necessary to assume a cold (?) as the cause of the disease. Torsion, invagination, and incarceration of the intestines may lead to inflammations which may become fatal in consequence of necrosis of the wall by perforative peritonitis. Croupous enteritis is observed in cattle either as an independent disease or as a symptomatic affection of malignant catarrhal fever and rinderpest. A hemorrhagic inflammation of the intestines is never absent in swine erysipelas. Croupous and diphtheritic inflammation of the mucous membrane of the posterior portion of the small intestine, as well as of the large intestine, is characteristic of hog cholera. According to Kitt, a diphtheritic intestinal inflammation may occur independently of hog cholera merely as a result of the necrosis bacillus.

Finally, the intestines exhibit serious alterations in enteric anthrax. Swelling, erythrism and hemorrhages of the mucous membrane are observed, and, in severe cases, also hemorrhagic and sero-hemorrhagic infiltration of the mucosa and submucosa, so that the mucous membrane is forced into the lumen of the intestine in the form of flabby ridges, and sloughs off. The duodenum is commonly affected most severely.

Fig. 56.



Calf abomasum with peptic ulcers of different sizes and depth. Largest ulcer is perforated.

Ulcus Peptícum. — Peptic ulcer of the stomach is an affection which is observed in calves rather frequently at slaughter-houses. The author has called attention to the fact that round and elongated ulcers with sharp borders and without apparent cause may occur in the rennet of calves. Frequently death is brought about by perforative peritonitis in consequence of the necrosis of the floor of the ulcer. Peptic ulcers may also occur in the duodenum. The frequency of the occurrence of perforative peptic ulcer of the stomach in calves makes it

the duty of inspectors to observe carefully the peritoneal changes in these animals in every individual case. The inflammation is sero-fibrinous. The inflammatory erythrism of the peritoneum under the fibrinous deposit furnishes a certain means of diagnosis, even when the deposit is carelessly removed during the inspection.

Judgment.—In perforative peritonitis, the meat must be considered as an unwholesome food material (see "Sapremia"). If, on the other hand, peritonitis is absent and the floor of the ulcer shows a granular formation, the meat may be offered for sale as a marketable food material, provided the animal is in a good state of nutrition. Occasionally the perforation heals by a connective tissue union at the point of rupture between the omentum and the abdominal wall.

Parasites.—The following parasites occur in the stomach and intestines: *Gastrophilus equi* (stomach of the horse); *G. nasalis* (pyloric portion of the stomach of the horse); *G. pecorum* and *G. hæmorrhoidalis* (stomach and rectum of horses and cattle); *Amphistomum conicum* (rumen and omasum of ruminants); *Filaria microstoma* and *F. megastoma* (stomach of the horse); *F. strongylina* (stomach of the hog); *Strongylus contortus* and *S. ostertagi* (fourth stomach of cattle, sheep and goats); *S. curticei* (fourth stomach and small intestine of cattle and sheep); *S. oncophorus* (fourth stomach and small intestine of cattle); *S. harkeri* (fourth stomach of cattle); *S. retortaformis* (fourth stomach and small intestine of cattle, sheep, goats, roebuck, hares and rabbits); *S. filicollis* (small intestine of sheep, especially in America); *Gnathostomum hispidum* (stomach of the hog); *Strongylus armatus* (cecum and colon of the horse); *Ascaris megalocephala* (small intestine of the horse); *A. lumbricoides* (small intestine of the hog); *Anoplocephala perfoliata*, *plicata*, and *mamillana* (horse); *Moniezia expansa* (cattle and sheep). Lastly, pentastomum larvæ are found in the wall of the small intestine in cattle and sheep.

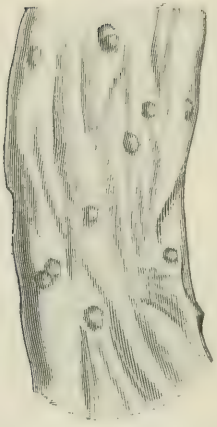
Strongylus ostertagi, but more frequently *S. contortus* and *Moniezia expansa*, when present in large numbers, may cause serious nutritive disturbances (stomach-worm disease, caused by *Strongylus contortus* and *S. ostertagi*, and tape-worm disease of lambs caused by *Moniezia expansa*). *Ascaris lumbricoides* occasionally wanders into the bile ducts and causes icterus by the sudden obstruction of the flow of bile.

Caseifying nematode tubercles in the wall of the intestine.—In the submucosa of the small intestine of cattle, Drechsler discovered a

nematode 1 to 1.5 mm. long, which was located in small, round tubercles with green-colored contents (Fig. 57). Saake confirmed this discovery soon afterward. The author has very frequently seen these tubercles in cattle killed at Berlin slaughterhouses. According to Ströse, the round worm which is found in the tubercles is a larva of Anchylostomum (*A. bovis*).

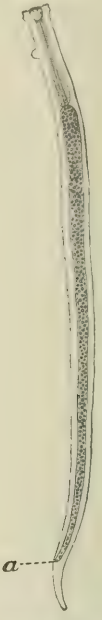
According to the thorough investigation of Ströse, the parasitic enteric tubercles of cattle are found exclusively in the small intes-

Fig. 57.



Bovine small intestine with submucous nematode tubercles.

Fig. 58.



Larva of *Anchylostomum bovis* from a submucous tubercle of the bovine intestine (after Ströse) × 25 diam.

tine in varying numbers. The spherical, often somewhat flattened, tubercles lie under the mucosa. They consist of a connective tissue wall and a green or yellowish-brown, caseous, crumbly content. The size of the tubercles varies from that of a pin head to that of a pea. The larger tubercles, even before the intestines are cleaned, may be seen from the outside through the muscular and serous coats.

The nematodes (Fig. 58) which were isolated from the tubercles by Ströse were 2.83 to 3.85 mm. long and 0.16 mm. wide.

In the small intestine of American sheep and cattle, Curtice also demonstrated nematode tubercles. In tubercles 1 cm. in diam-

eter, Curtice found larvæ and sexually-mature round worms to which he gave the name (*Œsophagostomum columbianum*. Further investigations are required to determine whether the European and American intestinal parasites are identical. Von Ratz came to the conclusion that the tubercles observed in European cattle contained *O. inflatum*. It should be remarked in this connection that nematode tubercles are frequently found in bovine intestines imported from America in such numbers that they look as if sprinkled with them. In the intestinal wall of chickens, von Ratz demonstrated grayish-yellow tubercles from the size of millet seed to that of hemp seed, which were due to penetration of the small tape worm (*Davainea tetragona*) into the intestinal wall. The parasites were located inside the tubercles. The chronic intestinal inflammation caused by *tetragona* may appear in an epizootic form and may cause the death of a large number of fowls, especially young ones.

Judgment.—According to the present state of knowledge, it can not be assumed that the parasites contained in the intestinal tubercles can be transmitted to man. On the other hand, intestines which are infested to a high degree with verminous tubercles are highly unfit for food in so far as the manufacture of sausage is concerned. In case of slight infestation, the tubercles may be removed. Meat dealers must be made personally responsible for this removal, since the tubercles are not seen until the intestines have been prepared for market in the usual manner.

Olt demonstrated another entozoic disease in the mucous membrane of the large intestine of hogs. In spring and summer a swelling and ulceration of a few or many follicles of the large intestine are observed in hogs. This infection occurs most frequently in the rectum and colon; less frequently in the cecum and the parts anterior to it. In the caseous contents of the follicular tubercles, Olt discovered the larva of a round worm (*Strongylus follicularis*), 1.7 mm. long and 1 mm. in diameter. According to Liebe, this is not a new parasite, but a hitherto undescribed immature form of *Strongylus dentatus*.

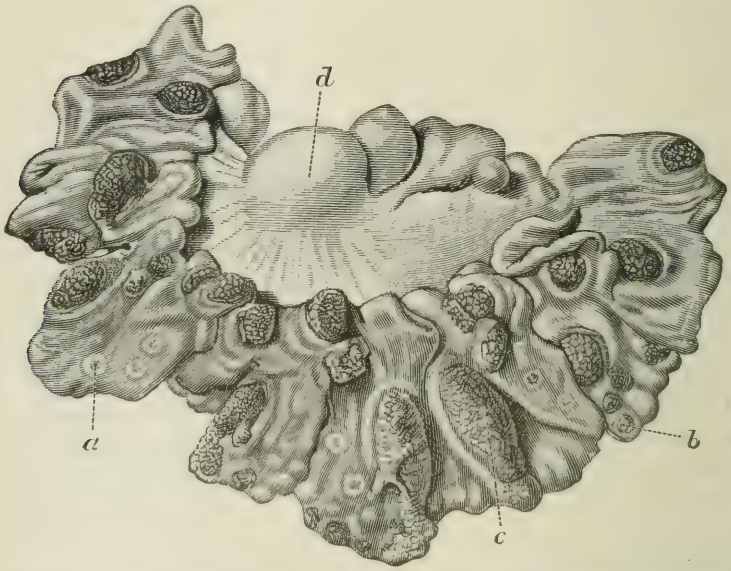
Finally, Liebe discovered in the mucosa, occasionally also under the serous coat of the cecum and colon of sheep, tubercles varying in size from that of a pin head to that of a pea, with yellowish or a yellow-green detritus. These tubercles likewise contained nematode larvæ. According to Liebe, this is not identical with Drechsler's nematode or *Anchylostomum bovis*.

Judgment.—The statement already made with reference to judgment of the tubercles in bovine intestines holds good for the

tubercles described by Liebe. On the other hand, the entozoic follicular tubercles discovered by Olt in the hog intestines require no further consideration in practical meat inspection, since they are removed in cleaning the intestines (by stripping the mucous membrane).

Diagnosis and differential diagnosis of nematode tubercles of the intestines.—The nematode tubercles in the wall of the intestines may be mistaken in superficial inspection for the products of tuberculosis. They are distinguished, however, from the latter by the gray or

FIG. 59.



Intestinal tuberculosis of cattle. *a* and *b*, lenticular ulcers; *c*, tuberculous infiltration; *d*, part of a tuberculous mesenteric gland.

grayish-green color of the caseous material and by the integrity of the corresponding lymph glands. By crushing the caseous material with the addition of glycerin (Linstow) or dilute caustic potash, the round worms may be easily isolated.

OTHER ALTERATIONS.—Among the other alterations in the stomach and alimentary tract may be mentioned hemorrhages under the visceral peritoneum (in intoxications and infections); hemorrhagic infarcts (in the horse by emboli from aneurism of the anterior mesenteric artery); necrosis of the mucous lining of the

anterior stomachs of cattle (caused by the necrosis bacillus); tumors, such as lipomata and sarcomata; and, finally, actinomycotic and tubercular changes in all layers of the alimentary canal and on the intestinal peritoneum. Sarcomata may infiltrate the whole wall of the intestine for a considerable length, or may be deposited in it as tubercles. Primary tuberculosis of the intestine begins with the appearance of lenticular ulcers on the mucous membrane (Fig. 59, *a* and *b*) with which tuberculous infiltrations of the mucosa and submucosa become connected later by the degeneration of the superficial tubercles (Fig. 59, *c*). Tuberculous ulcers and infiltrations are surrounded with a wall-like border. Furthermore, the mesenteric glands regularly show a marked specific alteration (Figs. 23 and 59, *d*).

Kitt describes "papilloma polyposum omasi (myxomatodes)" as a frequent condition in the stomach of cattle. Papilloma of the omasum is usually multiple in all transition stages from simple papillary hyperplasia and papillomatous rosettes of the size of the double fist. According to Kitt, they are best compared in a fresh condition "with the fruit of Muscatelle grapes." The berry-like structures possess a firm, elastic consistency, the color being partly milk white, partly of a reddish flesh tint. Edema from obstruction lends a myxoma-like character to the papilloma.

(e) Peritoneum.

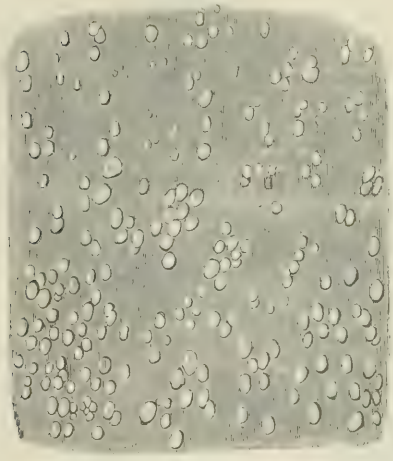
The parietal fold of the peritoneum may exhibit the same alterations which have just been described as occurring in the visceral layer and in the serous covering of the abdominal organs. This statement also holds good for the duplicatures of the peritoneum, omentum and mesenteries. Furthermore, there are certain processes which are peculiar to the parietal layer of the peritoneum, or have a predilection for it.

Multiple Calcification.—The peritoneum of cattle frequently exhibits an interesting calcification which may be confused with incipient tuberculosis. The calcification is distinguished by the appearance of a few or countless flat elevations varying in size from that of a pin head to that of a lentil (Fig. 60). The latter are of a white color and upon microscopic examination it becomes apparent that the normal tissue of the peritoneum is interrupted by cloudy spots. The cloudiness is due to acicular depositions in close contact with one another in the larger tubercles. According to their chemical behavior, these deposits must be considered as lime salts.

Multiple calcification of the peritoneum is distinguished from tuberculosis (Fig. 61) by the complete absence of caseation, as well as by the flat form and the absence of tubercles; also by the absence of an alteration in the corresponding lymph glands.

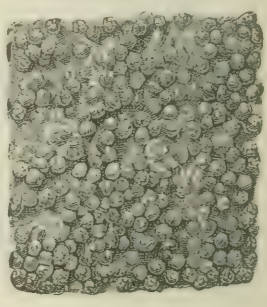
Inflammations.—Peritoneal inflammations are closely connected with alterations of the alimentary canal. From an etiological standpoint, inflammations of the urino-genital apparatus, especially of the uterus in female animals, and injuries of the abdominal walls are to be considered in this connection. All cases of peritonitis which I have seen in slaughtered animals were caused by injuries of the alimentary tract, of the urino-genital apparatus, or of the abdominal wall, or by primary inflammations of these parts.

Fig. 60.



Multiple calcification of the bovine pleura.

Fig. 61.



Serous tuberculosis of cattle (pearl disease).

Peritonitis of domestic animals is either purely fibrinous or sero-fibrinous, more rarely purulent. In extensive injuries of organs covered by the peritoneum, the exudation may decompose—ichorous inflammation of the peritoneum. Perforative peritonitis following injuries of the stomach and intestines is always of an ichorous character. This is the case also in so-called traumatic peritonitis of cattle, in which foreign bodies pass from the second or third stomachs into the body cavity.

Inflammations of the peritoneum following rupture of the bladder or in connection with necrotic cystitis are characterized by the intense urinous odor of the exudation. The odor clings to the

peritoneum even after washing out the abnormal contents with water; otherwise inflammatory phenomena in urinous peritonitis, as a rule, are only slightly pronounced.

Finally, we should mention the proliferating inflammation of the serous covering of the alimentary tract which may lead to an adhesion of the individual folds of the intestines.

Judgment.—With the exception of the last-named proliferating process and urinous peritonitis, peritoneal inflammations are of great sanitary importance. The proliferating processes are of no significance. They simply prevent the use of the affected portions of the alimentary tract for customary market purposes. Urinous peritonitis renders the meat highly unfit for food, but not dangerous. In exudative peritoneal inflammations, on the other hand, the conditions are favorable for the resorption of toxines and the origin of general diseases (intoxication or infection).

Fibrinous and purulent peritonitis in cattle may heal on account of the unusual resistence of these animals to fibrinous and purulent inflammations. The former heals by resorption of the exudation or a connective tissue adhesion of the affected parts; the latter heals imperfectly by encapsulation of the pus. With regard to judgment on acute peritoneal inflammations and healed purulent peritonitis, see "Septicemia" and "Pyemia."

Infectious pleuro-peritonitis of hogs.—According to the statistics of slaughterhouses, hogs are frequently attacked by a chronic inflammation of the pleura and peritoneum, in the course of which multiple, usually strongly encapsulated abscesses are formed.

According to Grips, who investigated the disease, this is a specific infectious disease of hogs (see under "Infectious Diseases").

Biliary peritonitis.—Finally, mention may here be made of a so-called biliary peritonitis which sometimes occurs in sheep. This disease may arise when the liver or gall bladder is injured. In the cases which I have observed, an artificial communication had been formed between the bile duct and the body cavity by liver flukes which had left their customary habitat and had bored through the liver substance and liver capsule. In biliary peritonitis, one finds a thickening, especially of the lower parts of the parietal peritoneum. The thickened parts of the peritoneum possess a bluish-white sheen and are covered with a greenish, glistening, semi-fluid deposit. In one hog I demonstrated a similar alteration of the parietal and visceral peritoneum. In this case the cause was a rupture of the pregnant uterus from torsion.

Other Alterations.—Of the other pathological conditions in the peritoneum, the following deserve mention: Melanin deposits in cattle, transudations and hemorrhages in rupture of the spleen and liver or in fresh perforation of the rectum and uterus, hemorrhagic infiltrations in anthrax, and sarcomata and carcinomata, as well as tuberculous granulations in the form of tubercles, pearl-like proliferations, and superficial deposits (Fig. 61).

Multiple fatty necrosis.—Multiple necrosis may appear in the adipose tissue under the parietal fold of the peritoneum, between the folds of the mesentery and in the omentum. Fischöder described such a case in a hog which was not carefully investigated by the author and was named fatty necrosis. Numerous yellowish-white opaque areas of lardaceous consistency were observed in the fat tissue. The size of the areas reached that of a five-pfennig piece. Olt and Steuding subsequently reported several cases of fatty necrosis in domesticated animals. According to the investigations of Benda and Stadelmann, multiple fatty necrosis is a sequela of diseases of the pancreas, tumors, lesions of the pancreatic duct, etc. The pancreas was also diseased in the case reported by Fischöder and in one of the cases described by Steuding. Jung produced local inflammation and fatty necrosis by the artificial introduction of trypsin and fresh pancreas into the body cavity of rabbits. He is of the opinion that the secretion of the pancreas, in consequence of a solution of the continuity of the latter, flows into the body cavity and causes fatty necrosis.

In rendering judgment on the meat of animals affected with multiple fatty necrosis, the condition of the animals before slaughter and the general findings after slaughter should be determining factors. If the animal affected with fatty necrosis is healthy before slaughter and if, after slaughter, the necrotic areas are found only in the fat tissues, the disease is to be considered an insignificant local affection, so far as the meat is concerned. On account of the abnormal condition of the fat tissue, however, the meat is to be offered for sale under declaration, as unsuitable food material.

Lipoma in adipose tissue of the abdomen.—According to Türcks, in food animals which have undergone a long course of fattening, adipose tissue tumors appear in the omentum and in the fat tissue of the intestines and kidneys in the form of hard, knotty thickenings which are called "fat stones" by butchers.

Mesenterial emphysema of hogs.—Mesenterial emphysema of hogs is a very remarkable disease which formerly was given the name

multilocular air cysts (Motz) and "air bladder mesentery" (pneumatosis cystoides intestinorum, Maier). The first description of this interesting affection was by Maier in 1825. Recently it has been described by Roth and Schmutzer. However, mesenterial emphysema is well known to meat inspectors as a frequent and striking phenomenon. It is observed that the small intestine, especially that portion of it known as the jejunum, is fringed along the line of attachment of the mesentery with grape-like evaginations

FIG. 62.

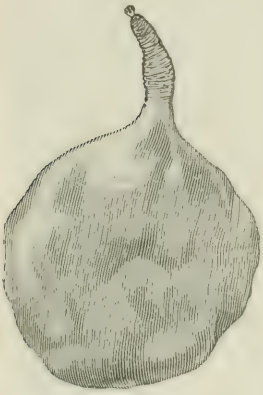
Mesenteric emphysema in hogs.

and appendages of varying size which are formed of cysts containing gas (Fig. 62). The appendages are tightly distended and do not communicate with one another. The wall of the cysts is transparent and only exceptionally of a red color from hemorrhage. In addition to the conglomerate groups, individual cysts appear, either in the intestinal wall and between the folds of the mesentery, or pedunculate on those parts. Accumulations of gas occur also in the mesenteric glands, sometimes to such a degree that the latter resemble sponge structures. The accumulation of gas, however, appears not to extend beyond the limits of the mesenteric glands. In connection with the gaseous cysts, solid tubercular filiform

formations are found on the peritoneum. Gas analyses, which the author undertook, with the contents of cysts obtained under quicksilver, indicate the presence of oxygen, together with a preponderating content of an inert gas, nitrogen. This had been previously established by Maier, Roeckl, Zschokke, and Roth. Dryer found in the cysts a mixture of 2.1 per cent. CO_2, 20.8 per cent. O, and 77.1 per cent. N. Krummacher, however, found, in addition to N, 10 to 16 per cent. O, while CO_2 and H were wanting or present only as a trace.

With regard to the etiology of mesenterial emphysema, we are still entirely in the dark. The author made an extended investigation of the disease and in spite of abundant and excellent material, for the most part still possessing the animal heat, only negative results were obtained. The investigations of Roth were also without result on this point. He combats the idea of Eisenlohr and Dupraz that the disease is due to a pathological organism demonstrable by present methods of research. It is undoubtedly a process of mycotic origin, and the author believes from the conditions in numerous microscopic preparations that it is necessary to consider yeast cells as the cause of this process, which is observed only in the pathology of domestic animals. No success, however, was had in cultivating the organisms in question. Schmutzer, with Krummacher, considers as excluded the possibility that the formation of the gas is due to micro-organisms, and is of the opinion that we have to do in this case with intestinal gases which have become changed in their composition by diffusion.

Fig. 63.



Cysticercus tenuicollis with artificially protruded scolex.

Motz ascertained that multilocular air cysts occurred most frequently in hogs which are fed upon the waste products of the dairy, and this observation was confirmed by others.

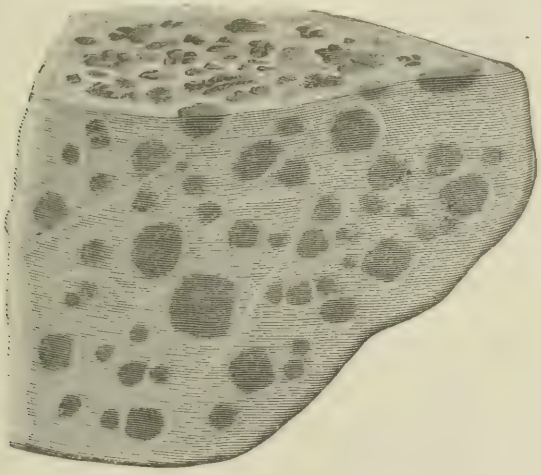
Judgment.—Mesenterial ephysema is found quite incidentally in hogs in perfect health and in good condition. Accordingly, and in view of the further unobjectionable character of the other vital organs and of the meat, this affection is to be considered as insignificant and of a purely local character No special measures are required with reference to affected parts of the intestine, since in consequence of the emphysema they can not be used as sausage casings.

Parasites.—The retro-peritoneal tissue, omentum, and mesentery furnish favorable situations for *Cysticercus tenuicollis*, which occurs there in sizes varying from that of a pea to that of a potato. Furthermore, echinococci and wandering liver flukes may occur under the peritoneum. Finally, in horses, *Filaria papillosa* has been observed free in the body cavity, as well as *Strongylus armatus*, which latter is also found under the parietal fold of the peritoneum; and occasionally *Spiroptera reticulata* attached to the peritoneum.

(f) Liver.

Malformations.—Occasionally lobulation is entirely absent in hog livers, so that the liver appears like an amorphous mass (non-

Fig. 64.



Beef liver with spotted capillary angiomatosis.

lobulated or clump liver). Furthermore, double livers (livers with accessory livers) and livers with a congenital cyst formation are observed.

In cattle one observes rather frequently a peculiar formation of the liver, which is described by Sluys, Koorevaar, Saake and Kitt, and was called by the latter spotted capillary angiomatosis. Such livers of the normal size and form exhibit numerous blue-black spots which become violet-red after lying for a long time and which occupy a deeper position than the normal liver surface (Fig. 64). The spots are of the size of a 25-cent piece, soft, and show a net-like structure on cross section. Blood is found between the meshes

of the net, which occasionally is very rich in leucocytes. The meshes are furnished with an endothelium; the lacunæ are therefore to be considered as enlarged capillaries and the whole anomaly a formation due to arrested development in consequence of the occasional failure of the liver cell cylinders to grow into the supporting substance. As a result, the capillary meshes are not sufficiently constricted (Kitt).

Saake the younger, in connection with the publication of his father, investigated ten cases of hepatic angiomata and came to the conclusion that the disease in question is characterized by "multiple bloody, infiltrated, blue-red areas varying in size from that of a millet seed to that of a cherry or even a walnut, and permeating the whole liver substance without changing the unaffected parts of the liver tissue." Microscopically, these areas are to be considered partly as hemorrhages, partly as angiomatous sinuses. In many cases alterations were observed in the blood vessels in the form of thrombi (eight out of eleven cases), liver cell emboli (six cases), rupture of the blood vessel (one case), infiltrations of the vascular walls with eosinophilous cells (five cases); also disintegration of the nuclei in the connective tissue cells of the walls into granular masses (two cases), transparent spherules in the blood masses and almost always proliferation phenomena in the connective tissue elements in the surrounding tissue. In these conditions, Saake sees a similarity with the changes described by Schmorl in the liver of eclamptic women, and his supposition that the hepatic alterations in question in cattle are connected with the act of parturition, is confirmed by the fact that the livers which he investigated came from cows. In four of the cases it was demonstrated that they had calved and the other was killed in consequence of parturient paresis. Saake, accordingly, does not agree with the interpretation of Kitt that we are dealing with congenital angioma, and he is strengthened in his dissenting opinion by the fact that, according to the experience of veterinarians engaged in meat inspection, the disease is not observed in virgin heifers.

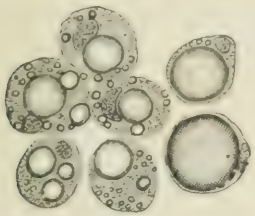
Finally, Stockmann is disposed to consider the hepatic alterations in question as the sequela of distomatous cirrhosis of the liver and as a simple enlargement of the hepatic capillaries. This view, however, is opposed to the fact that angioma of the liver is also observed without coexistent cirrhosis.

Judgment.—Livers affected with the above described alterations must be considered unfit for food, whether the affection is of the nature of angioma or hemorrhage. Special restrictions on the sale

of these livers is not necessary, since their nature is declared by their striking variation from the normal condition.

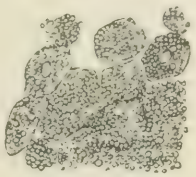
RUPTURES of the liver arise from the effect of violent mechanical shocks in the anterior abdominal region. A necessary condition, however, is an unusual discerptibility which usually is brought about by a strong fatty infiltration, as, for example, in fattened lambs. The animals die suddenly of hemorrhage. Upon post

FIG. 65.



Fatty infiltration of the liver.

FIG. 66.



Fatty metamorphosis of the liver.

mortem examination a bloody infiltrated rupture in the liver is observed, in addition to blood in the body cavity.

Judgment.—The meat of animals dead of rupture of the liver is to be considered the equal of that of animals slaughtered in the ordinary way, if evisceration occurs immediately after death.

ATROPHY.—Atrophy of the liver in old animals (horses and cows) has been discussed in the description of the normal structure of these organs. Furthermore, the so-called nutmeg liver occurs in food animals. This alteration is due to obstruction of the blood, in consequence of cardiac or pulmonary disturbances. The central veins of the acini of the liver become distended by the persistent obstruction, and bring about atrophy of the neighboring liver cells. The interior of the acini appears dark in color and the cortical zone is red-brown or yellow-brown. Simultaneously, a slight shrinking or enlargement of the liver occurs (atrophic and hypertrophic nutmeg liver).

Judgment.—Nutmeg liver is decidedly abnormal and must be considered as unfit for food.

PIGMENTATION.—A yellow discoloration of the liver is a regular symptom of hepatogenous icterus. By the aid of the microscope, a deposit of bilirubin crystals is found as a cause of the discoloration. Melanosis of the liver is also observed in calves.

A peculiar form of pigmentation of the liver is observed in Texas fever. The enlarged, superficially pale, on cross-section brownish-yellow, liver exhibits a delicate yellow network which encloses the trabeculæ of the liver cells. This pigmentation is due to a pronounced distention of the smaller bile ducts with thickened bile. In fresh preparations bile plugs of a Y form are conspicuous.

Degenerations.—The degenerative conditions of cloudy swelling and fatty metamorphosis of the liver are of importance in meat inspection, since they are the first or, in premature slaughter, the only symptoms of serious infectious diseases and intoxications. With regard to the distinction between fatty metamorphosis and fatty infiltration, compare page 256.

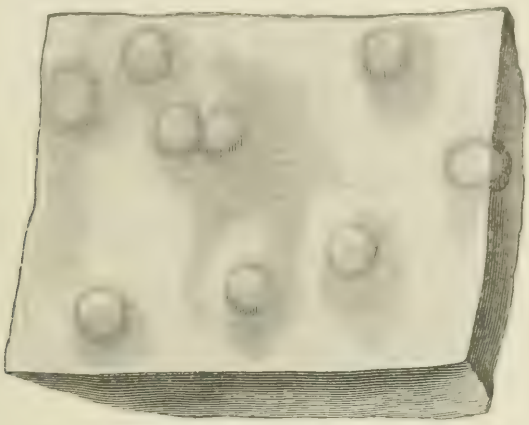
Rarely, amyloid degeneration of the liver is met with in food animals. The domestic hen has already been mentioned as the only exception. Livers affected with amyloid degeneration become enlarged, harder than normal, and of a dull gray color (spotted liver). In the horse, the firmness of the amyloid liver, according to Rabe, is about the same as that of wax while cooling, and later of the crumbling, soft consistency of half dried mortar. The livers of fowls affected with amyloid degeneration are friable, light yellowish red and to the touch are granular sandy (Kitt).

Hemorrhages.—Hemorrhages occur in the liver in two different forms: As a symptom of the serious effects of an excess of carbon dioxid, infection, or intoxication; and as a local affection in consequence of the destruction of the liver tissue by flukes which may have succeeded in boring through the bile duct and penetrating into the parenchyma of the liver. Hemorrhages of the first named sort are located under the capsule of the liver, and are of only slight extent, while traumatic hemorrhages may occur throughout the liver and are sometimes quite extensive. Traumatic hemorrhages terminate, as a rule, after resorption of the blood, in atrophic cirrhosis of the liver or in abscess of the liver, when pyogenic bacteria are carried into the liver tissue by the fluke worm. The flukes which cause traumatic hemorrhages are usually found only after considerable search, for the reason that they are constantly moving through the liver tissue by means of the peculiar arrangement of spines on their integument.

Judgment on traumatic hemorrhages of the liver is the same as that for capilliary angioma.

Necrosis.—Multiple necrosis of the liver is met with in hog cholera. The necrotic areas appear cloudy and friable; their structure is obliterated; otherwise the liver necrosis which occurs during the course of hog cholera is only of symptomatic value and

Fig. 67.



Necrosis of beef liver. Superficial foci.

without sanitary interest. Necrotic processes, however, may occur in the liver as idiopathic local affections. Bang made known the fact that the necrosis bacillus (see under "Hog Cholera") has the power of penetrating into the liver of cattle and of producing more

Fig. 68.

Necrosis of beef liver. Section through an affected liver.

or less numerous necrotic areas, according to the extent of the emboli caused by its presence (bacterial necrosis of the liver). Occasionally the disease is associated with inflammation of the navel (the author). The necrotic areas which appear in bacterial

necrosis of the liver are, as a rule, spherical, cloudy, firm, sharply delimited, and surrounded by a red zone. The necrosis bacilli discovered by Bang are found in the necrotic areas in clumps, especially on the borders between the healthy and necrotic tissues. The liver may become enlarged to five times its normal volume. The liver tissue lying between the necrotic foci is usually discolored as in icterus. Later the necrotic areas become delimited from the neighboring tissue by tough capsules of connective tissue, while at the same time the necrosed portions soften and become modified into green, friable pus with an acid reaction.

Judgment.—The necrosis bacillus has a decided tendency to localization It belongs to the anaerobic bacteria and loses its vitality in blood. Bacterial necrosis of the liver is, therefore, to be considered from a sanitary standpoint as a local affection, and the meat of animals affected with this disease as harmless. Nevertheless, the sale of this meat must take place under declaration if the animal was slaughtered during the febrile stage of the disease, or if the icterus has developed in consequence of the necrosis.

Inflammations.—The most frequent form of inflammation of the liver is interstitial hepatitis. This represents a chronic productive inflammation of the interacinous tissue which may lead to a considerable increase in volume (hypertrophic cirrhosis of the liver), or to a striking decrease in volume (atrophic cirrhosis of the liver). In both cases there is an active proliferation of the connective tissue of the liver. In atrophic cirrhosis of the liver, however, a partial destruction of the hepatic parenchyma and consequently a shrinking of the whole organ may occur as a result of the cicatricial retraction of the newly-formed connective tissue. Hypertrophic cirrhosis of the liver is frequently observed in hogs to such a degree that the liver is enlarged to twice or three times its normal size and can no longer be penetrated with the finger. In the horse, cirrhosis of the liver is symtomatically an important phenomenon which accompanies the so-called Schweinsberger disease, a form of pernicious anemia; in cattle, it is a result of distomatosis. In the origin of cirrhosis of the liver in hogs, feeding alcoholic by-products appears to play an important rôle (Tschauner).

Judgment on productive inflammatory processes has already been discussed on page 262. Livers with a moderate formation of connective tissue should be admitted for sale without restriction. Those with a pronounced formation of such tissue, on the other hand, are unfit for food and should be sold under declaration; while

livers which have lost their normal consistency should be completely withheld from sale.

Hepatitis with abscess is a second form of inflammation of the liver. It may arise from pathogenic bacteria transported through the umbilical veins in new-born animals or more rarely through the portal vein in inflammatory processes in the intestine, or through the hepatic artery in pyemia. In cattle, abscess of the liver may be a sequela of hepatic necrosis (page 295). Hepatic abscesses are commonly sterile, which fact is ascribed by Teissier to the bactericide action of the hepatic glycogen.

For judgment on hepatitis with abscesses, see under "Pyemia."

Inflammation of the bile ducts.—The bile ducts (as well as the liver tissue) may be altered by inflammatory processes. The most frequent form of inflammation of the bile duct is distomatosis, characterized by a thickening of the walls and occasional calcification. A chronic inflammatory process may secondarily involve the liver tissue through the larger bile ducts, and may cause a partial or total cirrhosis.

A chronic inflammation of the walls of the bile duct is observed to a slight degree in consequence of obstruction of bile by the presence of biliary calculi in the efferent duct. A clear, greenish-yellow bile flows out of the thickened and distended bile ducts in such cases in contrast with the dirty, oleaceous substance which is discharged from bile ducts infested with liver flukes.

Judgment on inflammations of the bile ducts will be determined according to the degree of sympathetic affection of the liver tissue. As a rule, it is sufficient to remove the affected bile ducts for the purpose of putting the liver into marketable condition.

Tumors.—The liver of food animals may be the seat of primary and secondary sarcoma and carcinoma. Furthermore, in hogs and calves, leukemic infiltration is observed as a symptom of leukemia and pseudo-leukemia. The liver in such cases is much enlarged, is light-gray or grayish-brown in color, and tough. A close examination shows that the interacinous connective tissue is greatly distended in consequence of leukemic infiltration.

For judgment, see under "Tumors" and "Leukemia."

Multiple primary adenoma in the liver of the horse was described by Kitt. The liver was infested with hundreds of tubercles of different sizes, from a grain of sand to a potato. The tubercles

were irregular in form, yellowish-white in color, and of a hard, elastic consistency. Tubercles were also found in the portal lymph glands. Under the microscope they exhibited numerous tubes of cylindrical epithelium which were forced together. Furthermore, adenoma of the liver is also observed in cattle and sheep.

Martin made a report concerning cavernous tumors (cavities varying in size from that of mustard seed to that of a hazel nut and filled with blood). These tumors were present in the liver and other organs.

Infectious Granulations.—Of the infectious granulations in the liver, mention should be made of tubercles, glanderous neomorphs, actinomycomata and botryomycomata, the bacterial organisms of which are introduced into the liver either through the portal vein or through the hepatic artery. Hepatic actinomycomata arise regularly from one of the first stomachs. Direct invasion of the liver by actinomycomata from the anterior stomachs has been observed, as well as eruption of actinomycotic tumors in connection with wounds of the liver caused by infected foreign bodies which penetrated the liver from the reticulum. That hepatic actinomycosis is not rare is shown by a statement of Rasmussen, who identified twenty-two cases of the disease in the abattoir at Copenhagen in the course of a year.

Attention should be called to the fact that tuberculosis of the liver frequently occurs in hogs in a form which may easily be confused with simple interstitial hepatitis. Upon close examination, however, casefied and calcified foci are observed in the strongly-proliferated interacinous connective tissue of tuberculous hog livers, quite aside from the fact that the portal lymph glands exhibit the most pronounced tuberculous changes.

Parasites are very frequent in the liver, especially echinococci, flukes, *Cysticercus tenuicollis*, and, more rarely, pentastomum. All of these parasites will be considered in greater detail under "Invasion Diseases." Attention may here be called merely to the fact that the dangerous bladder worms, *Cysticercus bovis* and *C. cellulosae*, occur only in cases of most serious invasion and that in by far the greater number of cases of bladder worms in the liver, *C. tenuicollis* is the species concerned. The fact that the latter in its larval stage resembles externally the dangerous bladder worms (compare Fig. 69), has led to unwarranted condemnation of whole animals.

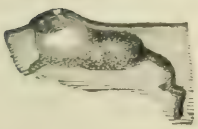
In hogs, one finds coccidia in the liver in addition to the above-named parasites. They produce tubercles varying in size from a pea to a walnut, with cloudy, brown, oleaceous contents, in the neighborhood of which a pronounced cirrhosis of the liver tissue is developed.

Coccidiosis is of frequent occurrence in rabbits (Fig 70).

The wandering of round worms into the bile ducts has already been mentioned. By sudden obstruction of the bile ducts, they bring about icterus and, under certain conditions, multiple necrosis of the liver (effect of retained bile).

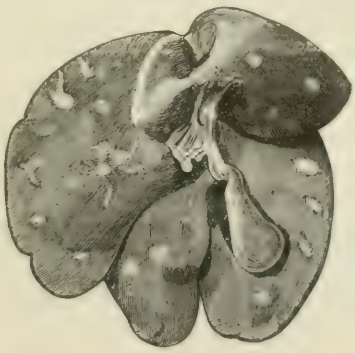
"*Calcareous-fibrous*" *tubercles of the liver.*—Yellow and yellowish-brown formations, varying in size from a pin head to millet seed, and characterized by Kitt as calcareous-fibrous tubercles, are

Fig. 69.



Young Cysticercus tenuicollis *in situ* (after Leuckart).

Fig. 70



Rabbit liver with coccidia.

rather frequently observed in the liver of the horse. Kitt considers them "primary healed necrotic areas, such as may arise in omphalophlebitis of foals (embolic infarcts of minute caliber)." Dieckerhoff, on the other hand, regards them as a product of vegetable parasites. According to Willach, the tubercles appear, as a rule, to be of zooparasitic origin. On two occasions he found egg-shaped structures in such tubercles which he considered to be eggs of an oxyuris. In the third case, Willach succeeded in demonstrating operculate eggs of a parasite in the tubercles; and, in the fourth case, developmental stages of a distome such as occur in the lungs. Von Ratz also observed dead specimens of a distome filled with eggs in calcareous-fibrous tubercles of the liver. Finally, Olt demonstrated prematurely disintegrated echinococci in the tubercles.

The reproductive power of the liver in partial destruction of the liver tissue as a result of parasitic invasion is remarkable. The infected parts of the liver show, according to the degree of destruction, a greater or less increase in volume as a result of proliferation of the liver cells, of the biliary capillaries and of the connective tissue (Ponfick).

Cadaverous alterations.—The great susceptibility of the liver to decomposition by putrefactive bacteria is well known. In beef livers, however, one can observe the origin of putrefactive gas bubbles under the liver capsule within from one to two hours after slaughter. This unusually rapid decomposition is due to befouling the liver with the stomach contents; for portions of the latter may pass into the open vena cava, thence into the hepatic veins, if the contaminating matter is not entirely removed, but merely washed off superficially. It would be advisable to open up the larger branches of the hepatic veins and wash them out. In consequence of its high content of glycogen, the liver may also undergo an acid fermentation (compare the chapter on "Post Mortem Changes").

(g) Pancreas.

Diseases of the pancreas are rare occurrences in domesticated food animals. Concretions (pancreas stones) are found in the efferent ducts of the pancreas with comparative frequency. The efferent ducts of the usually simultaneously-indurated organ are enlarged and filled with milk-white concretions varying in size from a millet seed to a hazel nut. According to Bär, they are composed of carbonate of lime, traces of carbonate of magnesia, and an undetermined organic substance. Furthermore, tumors are observed in the pancreas and, in tropical countries, also a parasite (*Distomum pancreaticum*) in sheep, cattle and buffalo.

Marek called attention to a frequent necrosis of the adipose tissue of the pancreas in old, fat, Mangalicza hogs. In such cases, irregular, sharply-defined tubercles, varying in size from a poppy seed to a pea, are found in the interacinous tissue of the pancreas, which, as a rule, is strongly developed. The tubercles at first possess a slight sheen; later they become dull and cloudy; their color varies from a yellowish-white to a grayish-yellow. The pancreas increases in volume and its consistency becomes firmer as the number and size of the tubercles increase. In the most severe cases of the disease, the pancreas may enlarge five times and may form a firm, hard, bilobed body. The glandular tissue remains completely

intact. This explains why the general condition of the animal is not disturbed in consequence of the disease, and especially why diabetes does not occur. Marek demonstrated by inoculation and microscopic examination that the disease studied by him was neither of an infectious nor parasitic origin.

Judgment.—Marek rightly maintains that, according to the nature of this disease, an injurious effect upon the character of the meat can not be assumed to occur. In fact, the meat should be sold without restriction, if no changes have occured in other organs.

3.—Urino-Genital Apparatus.

(a) Kidneys.

Malformations.—The most frequent malformations of the kidneys are unilateral congenital aplasia (with vicarious hypertrophy of the other kidney); unilateral or bilateral fissure of the kidneys, symphysis of both kidneys (horse-shoe kidneys), and congenital cystic kidneys.

Lime and Pigment Deposits.—Deposition of lime is occasionally found in sheep in the form of striæ in the medullary layer of the kidneys, and frequently in cattle in the form of concretions in the renal pelvis (nephro-lithiasis). As a rule, in the latter case there is at the same time a moderate chronic interstitial nephritis which leads to partial shrinkage. Furthermore, hemoglobin and bilirubin may be deposited in the kidneys.

Degenerations.—With regard to degenerations of the kidneys the same statements may be made as with reference to the liver. Attention should be called, however, to the fact that cloudy swelling and fatty metamorphosis of the kidneys indicate a more serious diseased condition of the whole organism. Furthermore, in order to avoid errors in diagnosis, it should be noted that fatty infiltration occurs in the kidneys of fattened animals and causes a cloudiness similar to that of fatty metamorphosis (compare page 175).

Hemorrhages in the kidneys are of diagnostic interest, for they may be symptoms of acute and chronic unhealed purulent processes; for example, osteomyelitis. Furthermore, hemorrhages occur in the kidneys under the same conditions as in the liver.

Infarcts.—The formation of infarcts may appear in the kidneys, since they contain terminal arteries. Hemorrhagic infarcts are

conical, with the base outward. Their color is first red, then cloudy gray-yellow or yellowish-white. The issue in benign emboli is cicatrization; in infectious cases, the formation of pus under certain conditions. Lustig described multiple formation of infarcts in the kidneys of a horse which was due to bilateral verminous aneurism of the renal arteries.

Inflammations.—Inflammations of the kidneys are due to various conditions and are therefore of varying importance for meat inspection. *Acute parenchymatous nephritis* may accompany intoxications, as excretion nephritis (from cantharides), or acute infectious diseases (swine erysipelas), and pyemic and septicemic processes. In such cases the kidney is swollen.

Purulent nephritis is a second important form of renal inflammation. This is characterized by the appearance of numerous, mostly small, abscesses surrounded by red zones in the cortical and medullary layers of the kidneys. It may arise from a partial acute nephritis (purulent areolar nephritis); also from emboli (embolic purulent nephritis); and, finally, from a purulent process spreading from the urethra and bladder (pyelo-nephritis). In both of the first cases, the abscesses lie almost exclusively in the cortical layer; while in pyelo-nephritis, they are primarily in the medullary layer.

The author frequently observed ascending purulent nephritis associated with purulent cystitis in wethers, and once also in a calf in which a diphtheritic inflammation had extended from the urachus to the bladder and thence to the ureters and kidneys.

Judgment.—In the last-mentioned cases, the meat had to be prohibited from sale, since the animals showed symptoms of acute pyemia. In purulent aerolar or embolic purulent nephritis, on the other hand, the animals may exhibit completely normal conditions in other respects. The meat of such animals is to be admitted to sale without restriction, if the primary foci are considered as healed.

The third principal form of nephritis is *chronic induration*, so-called contracted kidneys, in which the surface becomes granulated and a symphysis arises between the renal capsule and the surface of the kidneys.

Judgment.—Contracted kidney in food animals, according to present knowledge, does not possess as much significance with reference to the general condition as in man. It is of interest to us

merely as a local affection which should be judged analogously to cirrhosis of the liver.

We are indebted to Kitt* for a comparative account of the forms of nephritis which occur in domesticated animals. This author distinguishes the following forms:

Parenchymatous nephritis.—Parenchymatous inflammation of the kidneys is characterized by a moderate or not demonstrable swelling or by a ready separability of the tunica propria, greater prominence of the glomeruli, cloudy coloration, especially on cross section, greater fluid content of the latter, and hyperemia of the medullary substance. Hemorrhagic parenchymatous nephritis is a special parenchymatous nephritis which is characterized by the presence of numerous minute red hemorrhagic spots and is observed in typical development in swine erysipelas. Kitt proposes the term acute, diffuse nephritis and hemorrhagic nephritis for those conditions in which true inflammatory alterations and other conspicuous symptoms are present in high degree.

Purulent renal inflammations.—These are either embolic (metastatic) or ascending (urogenous). Furthermore, purulent processes appear, the causes of which can not be demonstrated anatomically.

In purulent embolic nephritis (punctate, disseminate, diffuse, mixed), the whole organ, especially the whole cortical region, is invaded by abscesses which are surrounded with a bright-red zone and dark-red hemorrhages. The renal pelvis is unchanged, but may contain a bloody urine rich in leucocytes. Bacteria, especially groups of micrococci, are demonstrable in the purulent infiltrated regions. The process involves both kidneys. This form of nephritis appears to be more frequent in hogs, but is also observed in a perfectly typical development in the calf. Kitt applied the term mixed purulent nephritis to that form of inflammation which very frequently occurs in the calf and in which the hyperemic zone is smaller, while the whole cortex is discolored, dirty whitish gray, and oozes on section (combination of purulent degenerative inflammations and of those which lead to hyperplasia of the connective tissue).

Ulcerative and vegetative endocarditis, pyemia, and pulmonary cavities are to be considered the causative factors of purulent nephritis. In this connection Kitt calls attention to the experiments

* Monatsh. für Praktische Tierheilk., IV, Nos. 11 and 12.

of C. Fränkel, who produced artificially a disseminate purulent nephritis by intravenous injection of *Staphylococcus pyogenes aureus* in rabbits (whitish areas of the size of a bean or extensive pyramidal infarcts).

The larger encysted purulent areas in the kidneys are characterized by Kitt as apostematous nephritis (abscess or apostema of the kidney). Kitt distinguishes apostematous perinephritis and paranephritis, perirenal abscess and pyonephrosis. Apostematous nephritis may be of embolic, urinous, and, perhaps, also, of traumatic origin.

Kitt considers the comparatively frequent "white spot kidneys of calves" (nephritis fibro-plastica or nephritis maculosa alba, according to Kitt) as a transitional stage between acute and chronic inflammation. The macroscopic alterations in white spot kidney are sufficiently well known to all meat inspectors. We are indebted to Rieck for a detailed description of this condition. According to Kitt, fibro-plastic nephritis is "either from the very beginning a progressive process of induration, perhaps caused by microorganisms which are not pyogenic and which pass through the kidney; or it is the second stage of a purulent nephritis * * * in which the slight exudative deposit in small quantities is resorbed or removed through the urinary canal, and productive inflammation becomes predominant." The regular affection of both kidneys, the wedge shape, disseminate, or multiple arrangement of the white areas, and the frequent presence of red borders and hemorrhages are unmistakable signs of the embolic hematogenous character of the white spot kidney of calves. Kitt agrees entirely with Rieck, who, as is well known, described the disease in question as multiple embolic nephritis of calves. Fibro-plastic nephritis seems to disappear during the first years of life, but may, however, lead to multiple, diffuse sclerosis of the kidneys.

Glomerulo-nephritis is another inflammatory disease of the kidneys which is a forerunner of diffuse nephritis. A diagnosis is to be reached only on the basis of a microscopic investigation.

Kitt characterized as mixed nephritis those conditions in which interstitial inflammation and degenerative changes of the epithelium exist simultaneously. The kidneys are firmer than normal, cloudy, and red-yellow or gray spotted. The disease occurs from unknown causes in hogs.

Indurative nephritis.—Inflammations of the kidney, in which the most important phenomena are connective tissue proliferation,

sclerosis, or induration, are described by Kitt under the general name indurative nephritis (chronic fibrous nephritis). He distinguishes multiple depositions and absorption of connective tissue, which are frequent in cattle, as sclerosis maculata sive virgata, and diffuse hyperplasia of the connective tissues or sclerosis totalis sive diffusa renum. In extreme cases, which are occasionally observed in cattle, the kidneys are abnormally large, unusually hard, sometimes cut with difficulty, and grate on section (lime deposition). If the newly-formed connective tissue shrinks, a contracted kidney is formed, nephritis granulata (ren retractus).

Nephritis fibro-vesiculosa represents a rare form of inflammation. It is characterized by a cystoid degeneration of the urinary canal and by the formation of watery cysts which are thereby produced. The process is observed in a granular diathesis and also in simple induration of the kidneys.

Finally, bacterial nephritis of cattle is to be distinguished as a special form of inflammation (see below).

Among the renal inflammations mentioned above, fibro-plastic nephritis of the calf and bacterial pyelo-nephritis of old cattle possess considerable importance in meat inspection.

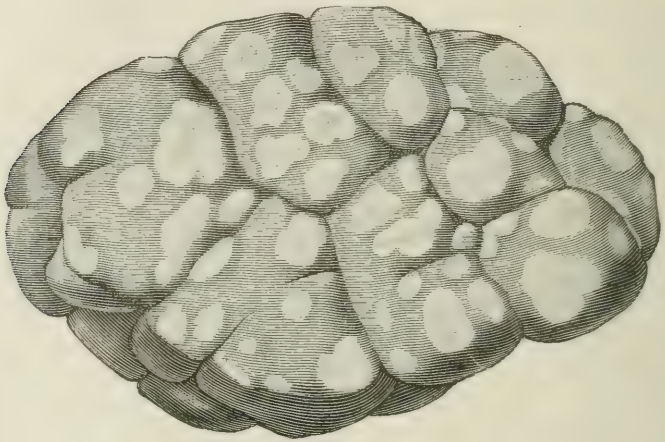
Fibro-plastic nephritis.—According to Rieck, this is the most frequent disease of calves. Among 26,000 calves which were slaughtered in the abattoir of Leipsic during the first half of 1890, Reick found pathological processes which led to condemnation in only seventy-two cases, and of these twenty-four, or $33\frac{1}{3}$ per cent., were kidney diseases. Multiple embolic nephritis, for which, from reasons given above, Kitt chose the term nephritis fibro-plastica, constituted the largest contingent of pathologically-altered kidneys.

Etiology.—According to the very plausible assumption of Kitt, the cause of fibro-plastic nephritis is to be found in micro-organisms of a particular species or pyogenic bacteria which have lost their peptonizing power and, therefore, exercise merely a stimulating action upon the formation of connective tissue. Rieck found in one case in which the foci had the appearance of putrefactive degeneration, micro-organisms of various forms, and in another equally recent case, structures which resembled the mycelia of mold fungi. Kabitz demonstrated the presence of bacilli, streptococci, and staphylococci in the diseased foci. The point of origin of fibro-plastic nephritis—that is, the organ from which the micro-organisms of fibro-plastic nephritis pass into the blood circulation—can not, as a rule, be determined at slaughter. As Reick indicated, the navel

can not be assumed to be the point of origin. It is more probable that the disease in question arises from the excretions of infectious material through the kidneys, in connection with frequent intestinal inflammation in calves. Rieck states that he was unable to determine any retarding influence of the disease upon the development of the animals. Vaerst considers spot disease of kidneys, not as products of pathological processes, but as the remains of incompletely-developed kidneys—blastem tubercles.

Judgment.—Fibro-plastic nephritis in calves in the majority of cases represents the last phenomenon of a general disease which has run its course. In favor of this hypothesis we have the absence of a primary alteration and the good nutritive condition of the

Fig. 71.



White spot kidney (nephritis fibroplastica) of the calf.

animals. In all these cases fibro-plastic renal inflammation has significance only as a local affection. The affected kidneys are to be prohibited from sale as highly unfit for food on account of their great deviation from the normal; while no restriction should be placed upon the sale of the meat. Vaerst also favored the admission of altered kidneys after convincing himself of their harmlessness and good flavor after roasting. In extremely rare cases, in which, in addition to the kidney disease in question, acute alterations exist in other organs, it is necessary to proceed according to their special characters (see under "Pyemia").

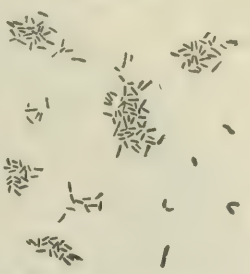
Bacterial Pyelo-nephritis of Cattle.—This disease of the kidneys is important on account of the frequency of its occurrence, and also

for the reason that when the bilateral affection occurs it may cause a serious disturbance of the general condition. In unilateral pyelo-nephritis, on the other hand, as a rule, such disturbances are not observed.

Pathological Anatomy.—In an examination of the body cavity the inspector notices first an enlargement and thickening of one or both ureters. After removing the kidneys from their protective covering, one observes that the kidney fat tissue has undergone a serous infiltration and that the kidneys are enlarged and the surface is either completely gray or spotted with gray. The most important changes, however, appear only on sectioning the kidneys. The renal pelvis is greatly enlarged and fully distended with a gray, slimy, purulent secretion of an ammoniacal odor. Triple phosphate crystals are found in the secretion. The mucous membrane of the renal pelvis and the adjacent medullary layer show swelling and diphtheritic ulcers. Cloudy streaks may be observed passing from the renal pelvis through the medullary layer to the cortical layer. Furthermore, small abscesses are found in the medullary and cortical layers.

Etiology.—As the investigations of Enderlen and Höflich have shown, pyelo-nephritis of cattle is caused by the so-called kidney bacillus (*Bacillus bovis renalis*, Bollinger). It is 2 to 3 μ long and 0.6 to .7 μ wide, sometimes slightly curved and rounded at the ends (Fig. 72). The kidney bacillus is non-motile and is easily distinguished from related bacteria by the fact that it is strained by the Gram method. In a case of pyelo-nephritis of cattle, Cadéac and Morot found a pure culture of *Bacillus pyocyaneus*.

Fig. 72.



Bacillus bovis renalis.

Judgment.—In an appendix to the work of Enderlen, Bollinger called attention to the fact that the kidney bacillus of cattle is characterized by its strict localization in the renal pelvis and tissue of the kidney. It shows no tendency to generalization.

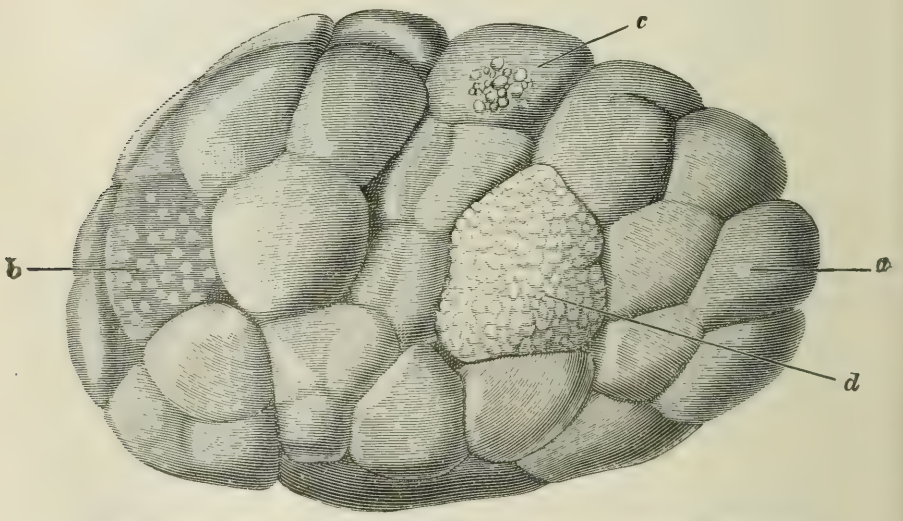
Unilateral pyelo-nephritis, as already mentioned, is frequently observed quite unexpectedly in well-nourished animals. In such cases the inspector should simply remove the affected kidney and ureter. If, however, both kidneys are involved and the disease has already led to extreme emaciation or to retention of the urine, the meat of affected animals is to be wholly excluded from human con-

sumption as highly unfit for food. In the latter case a urinous or ammoniacal odor develops during the cooking of the meat (see under "Uremia").

Tumors.—In the kidneys of food animals fibro-sarcoma and carcinoma (adeno-carcinoma) are observed. Furthermore, in leukemia the kidneys are altered specifically (enlarged and grayish-white in consequence of leukemic infiltration). Sarcoma and carcinoma appear either as a primary affection in the kidneys or develop here metastatically during general sarcomatosis and carcinomatosis. Primary carcinoma and sarcoma may attain considerable size. The author observed a case of renal carcinoma in a hog in which the affected kidney weighed 18 kg. Rieck described a case of adeno-sarcoma in the kidney of the hog in which the organ was changed into a spherical mass of $3\frac{1}{2}$ kg. weight. Tumors of metastatic origin were present in large numbers and sprinkled everywhere in the healthy tissue.

Infectious Granulations.—Through hematogenous infection the development of the tubercles of glanders or tuberculosis may

Fig. 73.



Bovine kidney with tuberculosis in different stages in the individual renculi. *a*, solitary young tubercle with incipient caseation; *b*, numerous tubercles of the same sort; *c*, older totally caseified tubercles; *d*, totally tuberculous renculus.

occur in the kidneys, and rarely, in cattle, actinomycomata may appear.

Tuberculosis of the kidneys first appears in the form of minute gray tubercles (Fig. 73, *a* and *b*) which remain scattered or form larger groups by a local dissemination (Figs. 73 *c* and 74). In the latter case, individual renculi may be completely destroyed (Fig. 73 *d*), while the rest of the kidney remains intact. Renal tuberculosis is distinguished from other changes in the kidneys by the presence of spherical tubercles with casefied centers (Fig. 73, *a* and *b*).

FIG. 74.

Section of a beef reniculus with tubercles in the medullary and cortical layers.

PARASITES are rare in the kidneys. They are the usual seat of *Eustrongylus gigas*. Moreover, *Sclerostomum equinum*, cysticerci, and echinococci sometimes occur in the kidneys.

Natterer found a nematode (*Stephanurus dentatus*, Diesing) in the fat capsule of the kidney in a Chinese breed of hogs. According to Leuckart, the parasite which he named *Sclerostomum pinguicola*, is occasionally found in our hogs in the fat capsule of the kidney. The male is from 20 to 26 mm. and the female from 30 to 36 mm. long. Raillet and Lucet demonstrated in emaciated geese white tubercles of the size of a pin head, consisting of masses of oval structures resembling *Coccidium oviforme* (*coccidiosis renalis*).

(b) Bladder and Urethra.

The changes to be considered in this connection may be briefly dismissed since serious diseases of the bladder and urethra, involving the general condition, are rare in domestic animals. Only in

oxen and wethers are diseases of the efferent urinary passages frequent, since in these animals cystic calculi are frequently formed. When large, the calculi may stop in the S-shaped curvature of the urethra, and lead to a rupture of the bladder with urinary peritonitis as a result, or to necrosis of the adjacent portion of the urethra with a urinous infiltration of the tissue surrounding the urethra. These sequelæ have all been discussed (see pages 273 and 286). Compared with these occurrences, the other alterations of the bladder and urethra possess but slight practical importance. With necrosis of the urethra from retained calculi a serious diphtheritic urocystitis may be associated (ascending infection of the contents of the bladder), and with this in turn a peritonitis may be associated (in partial necrosis of the wall of the bladder). In and of themselves, cystic calculi cause only slight superficial changes of the mucous membrane, even when they are present in large numbers. A cystic catarrh of greater or less severity is observed in cows after parturition; but, as a rule, it runs a purely local course.

A specific uro-cystitis appears to be the cause of "bloody urine," or hematuria, enzootic in cattle in the Black Forest. Arnold considered coccidia to be the cause of the disease which, from a pathologico-anatomical standpoint, was characterized as a chronic productive cystitis with papillomatous and polypous neomorphs of the mucous membrane which showed a tendency to hemorrhage (Gmelin).

Finally, an emphysema may occur in the mucous membrane of the bladder, caused by gas-producing bacteria. Bunge described a case of this sort in which the disease affected simultaneously the mucous membrane of the renal pelvis.

Among the specific granulations, actinomycomata are observed in the urinary bladder (Ernst).

(c) Male Sexual Organs.

Of the diseases of the male reproductive organs, mention is required only of tuberculosis of the testicles. This is quite often observed in bulls and boars (Johne, Lydtin, Hess, Kitt, Schmidt, Laurie, *et al.*). Usually both testicles are completely casefied. The weight of a tuberculous testicle may reach 10 kg. Frequently tuberculous alterations are also met with on the surface of the testicles and sheath (Kitt and the author).

(d) Female Sexual Organs.

The most important changes in the region of the female reproductive organs are in the uterus, and the least important in the ovary. The diseases of the latter may be disregarded.

Uterus.

In the uterus the following phenomena are of importance :

Abnormal Contents.—The occurrence of mummified fetuses (lithotheria) or of dead fetuses undergoing maceration in the uterus should be mentioned only incidentally. The so-called foul fetuses alone possess significance (see under "Sapremia").

Lacerations frequently occur in difficult parturition. They are almost always dangerous lesions, for they may cause death immediately through hemorrhage or gradually through infectious peritonitis. The case described above (page 287), of laceration of the uterus during torsion, forms an exception ; likewise laceration during closure of the os uteri. In these cases bacteria are excluded ; when, however, torsion is accompanied with necrosis of the affected parts of the body of the uterus or of the vagina, a fatal infectious peritonitis occurs.

Inflammations.—The inflammations of the uterus deserve the most serious attention of sanitary officers. For, as the history of cases of meat poisoning teaches, they may, under certain conditions, render meat highly injurious to health. In this connection the acute inflammations which are associated with gross lesions of the uterine wall in retention of placenta or with decomposition of the fetuses seem to be especially dangerous (inflammations with malodorous exudation). In no other organs are equally favorable conditions found for the resorption of harmful materials as in the uterus immediately after parturition. For further details of acute metritis, see under "Septicemia."

Catarrh.—In contrast with the acute inflammations of the mucous membrane of the uterus, the superficial processes, chronic, slimy and slimy-purulent catarrh of the uterus play an unimportant rôle in meat inspection. They frequently develop pronounced local affections in connection with infectious vaginal catarrh or infectious abortion and are frequently met with unexpectedly in well-nourished animals. When of a more serious character, chronic

uterine catarrh may be accompanied with emaciation. In such cases the meat is to be considered unfit for food. Injuries to health from eating the meat of animals which are affected with uterine catarrh have never been observed, although the meat of such animals is almost always used for food.

Tumors of the uterus are quite often observed in cows. As a rule, they are fibromyomata (liomyomata). In several cases the author also observed diffuse sarcomatous infiltration of the whole wall of the uterus whereby it underwent an enormous enlargement. On sectioning a uterus altered in this way, the wall is found to be much thickened, white and firm ; the mucous membrane, on the contrary, is atrophied. Occasionally, moreover, carcinoma of the uterus is observed in food animals.

Tuberculosis.—Tuberculous affection of the uterus may appear in three forms : (1) As primary uterine tuberculosis produced by coitus. This form is characterized by the formation of ulcers and an abnormal secretion of the mucous membrane. (2) A second form is embolic uterine tuberculosis with eruption of tubercles under the mucosa. (3) The third and most frequent form is that which develops in chronic peritoneal tuberculosis by the spreading of the infection to the wall of the uterus. In the latter case a great increase in thickness may occur through tuberculous infiltration of all the layers of the uterine wall. Through subsequent calcification the uterus may become a cavity inclosed with inflexible walls, in which a cloudy, slimy, purulent secretion is constantly present.

A tuberculous affection of the oviduct is usually associated with uterine tuberculosis. The oviducts alone may be affected in the same way as the uterus, in connection with peritoneal tuberculosis.

Animal Parasites are not found in the uterus.

Vagina.

In the vagina we observe inflammatory conditions either of an independent nature (pustular eruption, purulent catarrh), or as symptoms of general diseases (rinderpest and malignant catarrhal fever). Pustular eruption and catarrh are without interest to meat inspectors, since they represent local alterations and the parts in question are not used as food. Furthermore, attention should be called to the fact that the vaginal lesions do not possess the same significance as lesions of the uterus, for, as a rule, the former occur

in parts of the vagina which are without peritoneum and may, therefore, heal like simple wounds, without complications.

Fatal hemorrhages have been observed in consequence of injuries received during copulation (Beisswänger). More frequently, however, urinous infiltrations occur in the connective tissue within the pelvic cavity in consequence of injuries to the urethra received during copulation.

Finally, tuberculous alterations may appear in the mucous membrane of the vagina in the form of granules, tubercles, and ulcers. Moreover, in vaginal tuberculosis, Gärtner's ducts are modified into firm strands which may be as thick as the finger.

Dieckerhoff described a contagious vaginal inflammation, *sui generis*, under the name "pernicious colpitis." This apparently rare disease forms an exception to the other diseases of the vagina, since it does not run a local course, but causes a fatal general disease. The meat is to be judged as in septicemia from wounds.

Udder.

Physiological Conditions. — Physiological hypertrophy is observed in the udder during laceration and atrophy after this period of activity in the gland. The udder during active milk secretion is enlarged and hangs flabbily on the abdominal wall. An atrophic udder, on the other hand, is small and may be enclosed and penetrated with fat to such an extent that apparently little remains of the mammary tissue. In heifers and young ewes in the condition of medium fatness, it is sometimes difficult to distinguish the glandular tissue from the fat tissue.

Black Pigmentation, as already mentioned (page 269), frequently occurs in the mammary region. The author observed a deposition of lime in the udder of a cow which was not of parasitic origin, but which occurred in an udder of normal size with perfect integrity of the supramammary lymph glands.

Mammary Edema.—In pregnant cows shortly before parturition, transudation occurs in the region of the udder in the form of so-called mammary edema. After the removal of the skin a clear amber-yellow serum, with slight admixture of corpuscular elements from blood, oozes out of the edematous udder. Inflammatory phenomena are absent and mammary edema is thereby distinguished from mammary phlegmon.

Inflammations.—Inflammations of the udder are of the highest importance. No animal is so frequently affected with mammary affections as the cow, and this fact is sufficiently explained by its intensive milk production. Favorable conditions for bacterial infections are thus brought about. Distinction may be made between parenchymatous mastitis, in which the secreting glandular tissue is primarily affected, and phlegmonous mastitis, which runs its course in the connective tissue stroma of the udder.

Parenchymatous mastitis may exhibit all degrees of inflammation, including necrosis. As a rule, however, mammary inflammation is a benign affection which may terminate with the destruction of the glandular substance, but affects the general condition only slightly or temporarily.

In phlegmonous mastitis one observes, in contrast to mammary edema, a diffuse redness and hemorrhages in the serous infiltrated tissue, and numerous white and red blood corpuscles in the exudation.

Judgment.—The common parenchymatous and phelgmonous inflammations of the cow's udder, which are so frequently called to the attention of veterinarians, possess only slight sanitary importance, since they are local affections. Those mammary inflammations in the cow which are characterized by the formation of numerous abscesses and frequently occur as sequelæ of aphtha and also septic mastitis in sheep, form the only exceptions to this statement.

Judgment on the meat in the latter case should be governed as in septicemia. In mastitis with abscess formation, on the other hand, judgment should be rendered according to the principles observed in cases of suppuration and pyemia (see "Pyemia").

Individual cases of mammary inflammation in cows have occasionally attained significance from the fact that they produced meat poisoning (meat poisoning in the towns of Cotta, Wurzen and Riesa). Johne and Gärtner, who investigated the first mentioned case of meat poisoning, assumed that the case in question was caused by mastitis due to *Bacillus enteritidis* of Gärtner. This case of mastitis, as well as those which have become known on account of cases of meat poisoning in Wurzen and Riesa, were distinguished from ordinary cases of inflammation of the udder by their serious effect upon the general health of the animal. The health was so affected that slaughter was necessary.

Etiology of mastitis.—On the etiology of mammary inflammations we have the following investigations: Kitt, following the teachings

of Ludwig Franck, that parenchymatous mastitis arises by infection, tested the effect of several bacteria by injection into the udder. In these experiments it was found that the organism of malignant edema, *Oidium lactis*, *Micrococcus tetragenus*, and cultures of soor could be injected into the milk cisterns without harm. Even *Staphylococcus pyogenes aureus* produced only a temporary swelling of the udder. In the subcutaneous connective tissue, however, the bacilus of malignant edema produced an acute inflammatory edema. An injection of the bacilli of blue milk and of fowl cholera caused a catarrhal mastitis. The "bacteria of mastitis" isolated by Kitt from others spontaneously affected with mastitis, invariably produced an acute indurative purulent mastitis. Kitt's mastitis bacteria must, therefore, be considered as the cause of the ordinary mammary inflammations. The disease can neither be transmitted to rabbits and mice subcutaneously, nor to hogs and guinea pigs by feeding.

Bang succeeded in isolating specific streptococci as the cause of a chronic mammary inflammation and from other inflammed udders he made cultures of streptococci, diplocci, staphylococci and bacilli, which, when injected into the milk cisterns, produced an inflammation of the udder. Bang demonstrated the same effect for the streptococci of contagious coryza. Guillebeau found *Staphylococcus mastitidis*, also *Galactococcus versicolor*, *G. flavus*, and *G. albus* to be the pathological organisms of mammary inflammations. Jonge succeeded in causing an acute mastitis by injecting *Bacillus enteritidis* (Gärtner) into the milk cisterns. In so-called "yellow going dry," which almost invariably leads to atrophy of the udder, Nocard, Mollereau, Hess, Borgeaud, and recently Zschokke, demonstrated long streptococci (*Streptococcus mastitidis contagiosæ*) as the cause of the disease. The streptococcus is not pathogenic for mice, guinea pigs, rabbits, dogs, or hogs.

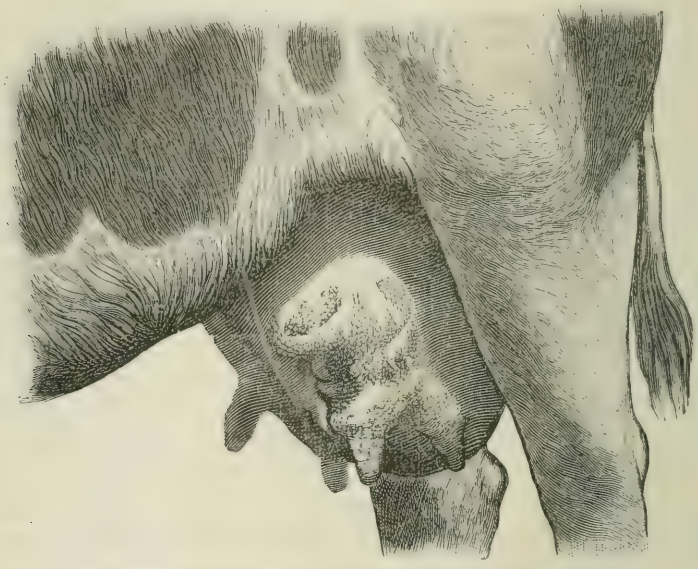
All the mastitis bacteria mentioned above are characterized by strict localization in the udder. This is not the case, however, with *Micrococcus mastitidis gangrænosæ ovis*, which Nocard isolated in gangrenous mastitis of sheep. This organism has the power to produce in the udder a septicemia which spreads and causes the death of the animal within a few days.

Tumors in the udder are common in only one domestic animal —the dog. They occur as chondrofibroma, lipoma, osteoma, myxoma, sarcoma, and carcinoma. The latter may arise primarily in the udder and may cause the formation of metastases. Accord-

ing to Kitt, in the larger domestic animals, mixed tumors, usually adenofibromata, occur in the udder. Rabe also described a case of hard cancer of the udder in a cow, with the formation of metastases in the lungs. It is well known that in white horses the udder is the most frequent seat of melano-sarcoma. Finally, in cows we frequently observe papilloma upon the integumentary covering of the udder.

Infectious Granulations.—The udder is frequently the seat of infectious granulations. In the horse botryomycoma is most common, while in cattle tuberculous alterations and actinomycomata

Fig. 75.



Mammary tuberculosis. Affection of both left quarters.

are most frequently developed. In the hog the mammary gland must be considered as the most common seat of actinomycotic affections.

Botryomycosis of the udder is characterized by the presence of hard, firm, knotty swellings in the mammary parenchyma, by adhesion of the skin with the affected parts, and by the formation of fistulæ with a slight discharge of pus mixed with minute structures resembling grains of sand.

Tuberculosis of the udder occurs in from two to four per cent. of all tuberculous cows and may appear in two chief forms: Tuber-

cular and diffuse mammary tuberculosis. In the first named form, tubercles up to the size of a man's fist may be found in the otherwise healthy mammary tissue. The tubercles are hard, firm, papillated on the surface, and exhibit caseation and calcification. Moreover, the tuberculous areas are readily distinguished from the pure white or yellowish-white mammary tissue by their pronounced gray color. The diffuse affection, which was well described by Bang in his classical treatise on tuberculosis of the udder, leads to enormous enlargement and induration of single quarters of the udder. The whole udder rarely appears to be involved in the tuberculous processes. One or more quarters of the udder are usually healthy and in advanced stages of the disease hang like appendices upon the affected quarters.

In the tubercular as well as diffuse form of mammary tuberculosis, a pronounced specific change regularly occurs in the supramammary lymph glands, and this is especially well marked in diffuse mammary tuberculosis. Tuberculosis of the udder is distinguished from all other pathological conditions of this organ by the constant sympathetic affection of the supramammary lymph glands.

Actinomycosis is of rare occurrence in the udder of cattle. Rasmussen observed four cases of actinomycosis in the udder of cows, either as firm, isolated tubercles or as diffuse, acute inflammation. In two of these cases the disease terminated with calcification of the fungus before the process had become greatly extended. Other cases of mammary actinomycosis have been described by Phail and Maxwell.

In the mammary region of the hog, on the other hand, actinomycosis is a comparatively frequent process. This is probably due to the greater vulnerability of the integument over the mammary region of the hog. The organisms of actinomycosis, carried on straw, thus effect an entrance more easily. For example, in the slaughterhouses of Copenhagen Rasmussen found fifty-two cases of mammary actinomycosis in hogs inside of three months. Mammary actinomycosis in the hog is characterized either by the appearance of tumors or occurs more rarely in the form of a tumor than as cold abscesses (mixed infection with pyogenic bacteria).

Among Parasites, echinococci have been demonstrated in the udder.

4.—Respiratory Apparatus.

(a) Nasal Cavity.

It is only in the horse that alterations in the nasal cavity occur, of such importance that an examination must be made in the case of each slaughtered animal after splitting open the head. In other domestic animals, inspection of the nasal cavity may be restricted to such cases as present phenomena during life which indicate disease of the nasal cavity.

The mucous membrane of the nasal cavity of the horse may exhibit the following alterations: Petechiæ, serous, slimy, slimy-purulent and simple purulent catarrh; croupous inflammations, the so-called follicular inflammation; fibrous and sarcomatous neomorphs, and, especially, glanderous processes.

Fig. 76.

Nasal septum of horse with glanderous ulcers and cicatrix.

Petechiæ of the nasal mucous membrane constitute an important symptom of petechial fever (morbus maculosus). Purulent inflammation is the chief symptom of contagious coryza. Both diseases are infectious and will be discussed under that head along with glanders. In this connection merely the macroscopical difference between the mechanical lesions of the nasal mucous membrane and glanderous alterations may be noted. Mechanical lesions of the mucous membrane are always found in the entrance to the nasal cavity and heal either without cicatrization (in superficial injuries) or with a smooth cicatrix (in deeper injuries). In glanders, on the other hand, one observes tubercles, ulcers with a lardaceous floor, eruption of tubercles in the peripheral parts, and also stellate cicatrices (Fig. 76). Croupous rhinitis may arise through chemical irritation or through a specific infection. Croupous rhinitis due to

chemical irritation has no significance for the inspection of horse meat on account of its benign course as a local affection. The same may be said of so-called follicular inflammation in which tubercles, vesicles and rapidly healing ulcers appear, and may spread from the nasal mucous membrane upon the general integument. Moreover, catarrh of the nasal and communicating cavities has no special significance in meat inspection.

In cattle the nasal cavities are to be closely inspected in case of symptoms of malignant catarrhal fever; in sheep, in so-called ovine glanders (malignant catarrhal fever of sheep), and in affections caused by the larvæ of œstrus; and in hogs, in so-called snuffles.

The last-named disease is characterized during life by a wheezing respiration. This is caused by a contraction of the nasal passages and may be due to various processes. The most frequent cause, however, is a rachitic swelling of the upper jaw, from which snuffles derived its name. In a large number of cases the author observed only rachitis of the upper jaw as the cause of snuffles.

Judgment should be the same as for rachitis.

Schneider reported a form of snuffles caused by the rudimentary development and curvature of the turbinated and ethmoid bones. This may lead to a bloody purulent nasal discharge with emaciation and even death by cachexia or asphyxia. If such animals are emaciated, the meat is to be considered as unfit for food. Nothing is known concerning its possible harmfulness. Moreover, in cattle, tuberculosis and actinomycosis appear on the nasal mucous membranes; and in dogs, *Pentastomum taenioides* in the nasal cavities and frontal sinuses.

(b) Larynx and Trachea.

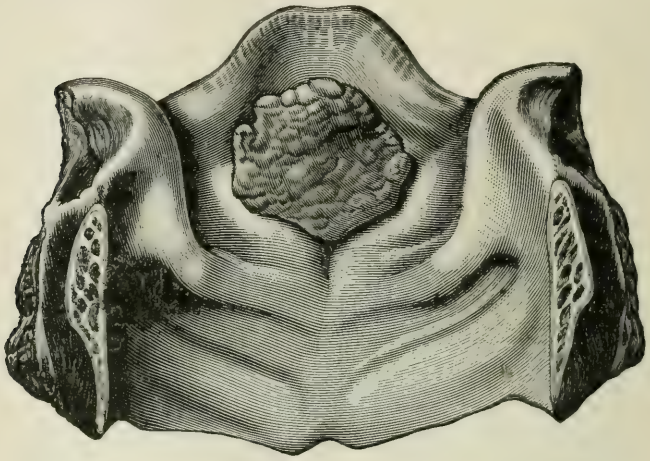
The larynx and trachea are rarely the seat of independent diseases aside from catarrh. Attention should merely be called to the fact that croupous inflammation of these parts may be caused by chemical irritation (for example, pungent gases), or may be observed as a symptom of malignant catarrhal fever and rinderpest.

Glanderous, actinomycotic and tuberculous alterations show a predilection for the larynx. The laryngeal actinomycomata which frequently appear as primary affections in cattle are located on the mucous membrane and are either pedunculate or with a broad base (Fig. 77). In the trachea of cattle tuberculous alterations occur on the mucous membrane and also in the submucosa of the posterior wall.

The statement concerning the trachea applies also to the larger bronchial tubes. As pathological curiosities, mention should be made of bronchiectases and peribronchitic processes which arise in connection with inflammation of the mucous membrane.

In the trachea of fowls, *Syngamus trachealis* is found as a parasite. Raillet described another species of Syngamus, *S. laryngeus*, as occurring frequently in the larynx and in the upper portions of the trachea of cattle in Anam (farther India.).

Fig. 77.



Bovine larynx with an actinomycoma on the epiglottis.

(c) Lungs.

Atelectasis.—Atelectasis is frequently observed in the lungs of food animals. As a rule, it is a congenital peculiarity and confined to small pulmonary areas. The parts of the lung thus affected are brownish-red, firm, and do not contain air. The bronchial tubes leading to the affected parts are, as a rule, in a catarrhal condition in older animals.

Dissolution of Continuity.—In addition to gross dissolutions of continuity in the lungs (from stabs, shot wounds, broken ribs, etc.), a less extensive form should be mentioned; namely, interlobular emphysema. This arises by rupture of the alveoli. As a consequence of this rupture, air appears between the alveoli in vesicles varying in size from a millet seed to a pea. The air vesicles under the pleura are most sharply distinguished from the pulmonary

tissue. In animals which exhibited acute dyspnea during life and were, therefore, slaughtered, there may be accumulations of air in large cavities which are partly filled with blood. Furthermore, in violent respiration the air may be forced into the mediastinal spaces and thence under the parietal pleura as well as into the connective tissue surrounding the trachea and, finally, from these locations even under the general integument.

Deposits of Pigment and Lime.—Partial or complete melanosis of the lungs frequently occurs in calves. Calcareous deposits, on the other hand, are exceedingly rare. In one such case observed by the author, the lung had only partly collapsed. Numerous hard structures of irregular, angular form could be felt. They could not be removed from the lungs except with the attached pulmonary tissue. After dissolving the lime salts by means of acetic acid, the pulmonary tissue appeared merely as an organic basis for the calcareous deposits. This true calcification of the lungs is essentially distinct from zooparasitic and phytoparasitic calcifications, which are observed in the lungs in a variety of forms.

Disturbances of the Circulation.—Among the circulatory derangements which occur in the lungs, especial interest centers in hypostasis as a means of recognizing natural death and slaughter performed during the crisis of the disease. The pulmonary hypostasis which develops on the lowest portion of that side of the body upon which the animal lay while dying is not to be confused with so-called blood aspiration (see p. 331).

A brown induration may appear in the lungs in consequence of a persistent increase in blood pressure in the right ventricle. This is not infrequently observed in hogs (perhaps in connection with the frequency of endocarditis in swine erysipelas, as shown by Bang). The indurated lungs do not collapse ; they are brownish-red instead of rose-red and feel firm. Judgment should be the same as in proliferating inflammations.

Since the lungs are provided with terminal arteries, hemorrhagic infarcts may occur in them as in the kidneys. In the lungs, however, there is the possibility of the occurrence of extensive infarcts. The fate of pulmonary infarcts is not generally the same as that of renal infarcts. In the lungs, only infected infarcts with a tendency toward softening are of importance.

Pulmonary edema is characterized by the appearance of a frothy fluid in the alveoli, bronchioles, and bronchi. This condition

has no special pathognomonic significance, since it is a common phenomenon accompanying the decreasing cardiac powers immediately preceding death. The animals do not die because they are affected with pulmonary edema, but pulmonary edema arises because the animals are approaching death (Cohnheim).

Hemorrhages.—Pulmonary hemorrhages may be associated with lacerations of the pulmonary tissue, or by diabrosis as a consequence of pulmonary cavities. In the horse, wandering larvæ of *Strongylus armatus* have occasionally given rise to pulmonary hemorrhages.

Subpleural hemorrhages are observed under the same pathological conditions as retro-peritoneal hemorrhages (see under "Intoxications and Affections").

Inflammations.—Thickening of the pulmonary tissue in consequence of the filling of the alveoli with an exudation, so-called hepatization, is the anatomical criterion of pulmonary inflammation (pneumonia).

The etiology of the different forms of pneumonia which occur in food animals is a varying one. Pulmonary inflammations arise from a spreading of inflammatory processes of the mucous membrane of the bronchial ramifications to the pulmonary tissue (broncho-pneumonia), or in consequence of certain toxic substances circulating in the blood (hematogenous pneumonia). Traumatic pneumonia, which is caused by foreign bodies, for example, penetrating from the reticulum in cattle, plays only an unimportant rôle. Hematogenous pulmonary inflammations are, without exception, of bacterial nature. Broncho-pneumonia may be caused by mechanical irritation (inhalation of dust, parasites) and thermic and chemical inflammation (inflammation of smoke and irritating gases). Pathological micro-organisms (bacteria and mold fungi) constitute the chief causes of broncho-pneumonia. Aside from the forms of broncho-pneumonia caused by bacteria and mold fungi, verminous pneumonia alone possesses great importance. Finally, with regard to etiology, mention should be made of the organisms of infectious granulations (tubercle bacilli, glanders bacilli, actinomyces and botryomyces), which may obtain entrance into the lungs by inhalation or from a primary focus already existing in the body and may give rise there to their specific granulations accompanied by inflammatory phenomena.

Judgment on pulmonary inflammations from a sanitary stand-

point will vary (1) according to etiology ; (2) according to the degree of inflammation.

With regard to pulmonary inflammations it may be said in general that, if we disregard the forms of inflammation caused by the organisms of infectious granulations (tuberculous, glanderous, actinomycotic, and botryomycotic), they do not render the meat harmful according to our present state of knowledge. This may be considered as demonstrated for pleuro-pneumonia of cattle as well as for the other typical pulmonary inflammations of domestic animals by the fact that the meat of these animals has been eaten in innumerable cases without any ill effects. This fact has led to the passage of laws (Imperial Animal Plague Law) permitting the general consumption of the meat of animals affected with pneumonia. With regard to a number of other frequently occurring pulmonary inflammations which, from a bacteriological study, are known to be infectious diseases, as, for example, swine plague, it is commonly believed that the meat of affected animals may have an injurious effect. This belief, however, finds no support in veterinary experience. Swine plague was formerly regarded as a simple cold and this assumption brought it about that the meat of animals affected with this disease was sold in the market without any restriction. An extensive feeding experiment with the meat of animals affected with swine plague was thus instituted and no injurious effects were observed. In the literature of the subject, no unexceptionable case can be found of meat poisoning from eating the meat of animals which were affected with pulmonary inflammation. Infectious pulmonary inflammations behave in this regard exactly as other acute infectious diseases of domestic animals, such as rinderpest, black leg, and erysipelas of hogs, which are well known not to be transmissible to man.

The meat in cases of pneumonia may, however, become dangerous to health when, following upon pulmonary inflammations, processes develop which have the power of "poisoning" the blood (pyemia and septicemia). Pyemia may be associated with primary purulent pulmonary inflammations, as, for example, traumatic pneumonia, or with suppuration of specific pneumonic areas (complication of pneumonia of cattle and horses, and swine plague). Septicemia occurs, on the other hand, when septic organisms have opportunity to become located in the inflamed pulmonary tissue in association with the organism which caused the original inflammation. This appears to be possible only in cases of necrosing inflammations. Septicemia following pulmonary inflammations is rare. In hogs, at any rate,

pyemia is more frequently associated with the specific pneumonia of this animal (swine plague, compare "Septicemia" and "Pyemia").

The greater number of pulmonary inflammations will be discussed under "Infectious Diseases," since, as already indicated, they are merely the chief symptom of specific infections (pneumonia of horses and cattle; infectious pneumonia of calves, sheep and goats; hemorrhagic septicemia of cattle; and swine plague). Moreover, under the head of "Infectious Diseases," glanderous and tuberculous pneumonia will also be considered.

In this connection we shall discuss merely those pulmonary inflammations which do not owe their origin to specific bacteria. To this group belong broncho-pneumonia in consequence of the aspiration of foreign material, verminous pneumonia, mycoses, and traumatic inflammations of the lungs, which may arise in cattle from the penetration by foreign bodies from one of the anterior stomachs.

Aspiration Pneumonia.—In a broad sense, pneumonia of aspiration should include all forms of broncho-pneumonia which arise from inhalation of foreign material as well as those which are caused by inhaled microorganisms. In a stricter sense, pneumonia of aspiration includes only those inflammations which are caused by larger corporeal particles. The prototype of these forms is represented by so-called pneumonia due to foreign bodies or to the passage of fluids down the trachea. The latter terminates, as a rule, in gangrene of the lungs, and in the horse, in which animal it is most frequently observed, in death from putrid intoxication (see this subject). While aseptic foreign bodies or such as are not contaminated with pathogenic organisms become included in the lung tissue in the healing processes, the pathogenic organisms which are carried into the lungs in fluids through the trachea cause primary necrosis and thereby offer an opportunity for the secondary localization and development of putrefactive bacteria. According to observations made on slaughtered animals, the form of pneumonia due to the entrance of fluid through the trachea runs a more favorable course in cattle and hogs and more frequently heals by encapsulation than in the horse.

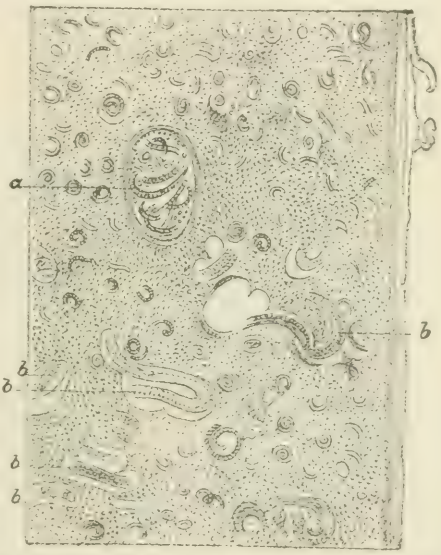
For judgment, see under "Sapremia" and "Septicemia."

Verminous Pneumonia.—Lung worms, as a rule, are found in the small bronchial tubes, in which they cause no serious alterations, except catarrh. In case of an extensive invasion, however, the

parasites may cause an inflammation of the lungs. This is most frequently the case in infestations of sheep by *Strongylus filaria* and of young cattle and deer by *S. micrurus*. Moreover, in sheep, there is another special form of verminous pneumonia, the so-called pulmonary hair worm disease, due to *S. capillaris* (Fig. 78).

The pulmonary inflammations due to Strongylidæ exhibit all the symptoms of acute broncho-pneumonia. At first there is a marked bronchitis. Associated with this, and in consequence of the lesions produced by the wandering embryos, is an inflammation of the pulmonary tissue in the form of lobular areas. The pneumonic areas may degenerate in case death does not occur from asphyxia or cachexia. In pulmonary hair worm disease, there are also lobular inflammations which, however, as a rule, run a benign course and leave only an inconsiderable residue in the form of small tubercular neomorphs or larger areas of infiltration in the pulmonary tissue.

FIG. 78.



Verminous pneumonia due to Strongylus capillaris (after A. Müller). *a*, embryos; *b*, parts of sexually mature specimens. The whole tissue is filled with embryos. As a result of desquamative pneumonia, the alveoli contain no air.

Judgment on verminous pneumonia, in so far as the meat is concerned, will depend entirely on whether the inflammatory processess in the lungs have seriously disturbed the general condition and whether emaciation has begun at the time of slaughter. In the latter case the meat is to be considered unfit for food; while it is to be excluded from the market as highly unfit for food when, in consequence of pneumonia, hydremic cachexia has developed with serous exudation in the body cavity.

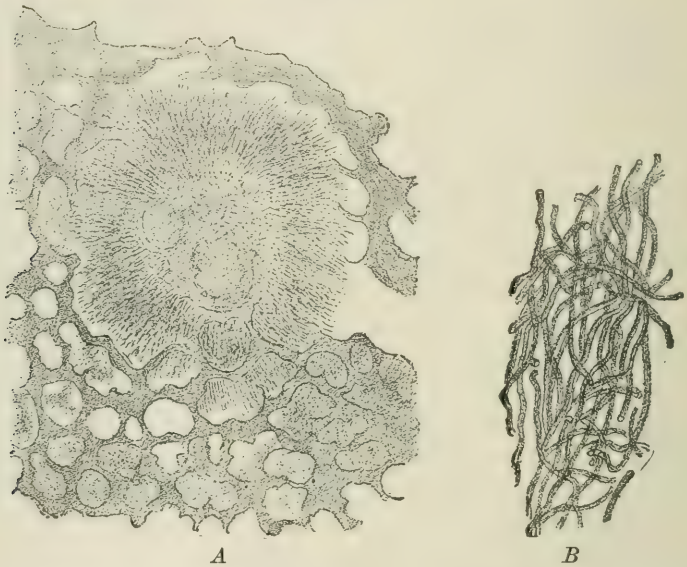
Mycosis of the Lungs Due to Mold Fungi.—It must be considered as demonstrated by numerous observations and by the experiments of Schütz and List, that mold fungi may produce pulmonary diseases in animals. This is most frequently the case in birds; occasionally

also, no doubt, cases of pneumo-mycosis are observed in mammals. Röckl, Martin, Lucet and Bournay described cases in horses and cattle; and Mazzanti a case in sheep.

These cases are commonly due to infection by pathogenic species of aspergillus, *A. fumigatus* and *A. niger*.

Aspergillosis of the lungs may be confused with tuberculosis, since it is ushered in with the formation of tubercles. However, protection against such an error is afforded by an examination of the bronchial glands (they are intact in infection by mold fungi), and by a microscopic study. According to Röckl, a closely-matted

Fig. 79.



Pneumonomycosis of cattle (after Röckl).
A, center of a pulmonary tubercle with fungous mycelia; *B*, isolated hyphæ.

mycelium is observed in the tubercles, caused by aspergillus. On the borders of the tubercles, however, relatively short hyphæ are observed lying closely together like sheaves radially arranged. A very characteristic structure, not unlike an aster, is thus produced (Fig. 79). Aspergillosis may also be readily distinguished from pleuro-pneumonia, to which it has a great similarity, by microscopic investigation.

In the case described by Röckl, the lungs were in part infested with tubercles of the size of hemp seed and in part exhibited the symptoms of extensive hepatization. The hepatized areas were

conspicuous for their marbled appearance. Furthermore, ulcers were found on the bronchial mucous membrane and stratified thrombi in the region of the hepatized portion.

The cases observed by Lucet ran a course with symptoms of septicemia, with hemorrhagic pneumonia, and ecchymoses in all organs. In the case described by Bournay, tubercles of the size of nuts were found with central cavities which were infected with fungi. Finally, in Mazzanti's case, the lungs were permeated with softened tubercles surrounded with red areas varying in size from that of poppy seed to that of hemp seed. The tubercles contained mycelia and spores.

Diffuse hepatization is observed in birds; and in the hepatized areas, which at first are colored red, are small gray, poorly defined specks. In microscopical preparations it is observed that not only the bronchioles, alveolar branches, and alveoli are filled with a septate and much-branched fungus mycelium, but that the interlobular tissue is also attacked by the indiscriminate proliferation of the fungus.

Judgment.—Aspergillosis appears not to be capable of transmission to man by way of the alimentary tract. The mycotic organs, however, are to be excluded from sale as highly unfit for food, while no restriction should be placed on the meat, since aspergillosis of the lungs is a purely local disease.

Traumatic Inflammations of the Lungs are of frequent occurrence in cattle. They are purulent inflammations which develop in the immediate vicinity of foreign bodies. Later the foreign bodies, as a rule, become encapsulated in tough connective tissue which lies about the foreign bodies in the form of a tube. These processes are especially noteworthy since an infiltration of the interlobular connective tissue, similar to that in pleuro-pneumonia, may develop in the first stages of traumatic pneumonia, beyond the purulent zone which surrounds the foreign bodies.

Tumors and Infectious Granulations.—Among the tumors which are observed in the lungs, mention should be made of adenoma, chondroma and metastatic sarcoma. Of the infectious granulations, we should mention the neomorphs of glanders (tubercles and lobular infiltration), tuberculosis (primary tuberculous broncho-pneumonia and embolic pulmonary tuberculosis), botryomycosis and actinomycosis. Pulmonary actinomycosis is not rare. As a rule, it develops secondarily in consequence of

aspiration of portions of disintegrated pharyngeal or laryngeal actinomycomata. In this case tubercles are found in the lungs varying in size from lentils to peas and sometimes of the size of a man's head. Moreover, actinomycotic cavities and tubercular actinomycomata are found on the mucous membrane of the bronchi. By transportation in the blood circulation, embolic pulmonary actinomycosis may arise in the form of disseminated tubercles lying in the interstitial pulmonary tissue. Pflug observed a case of this sort which was apparently without primary alterations in any other organ. Occasionally, pearl-like actinomycomata are also found on the pulmonary pleura (Rasmussen).

Parasites.—The lungs of domesticated animals and wild game are parasitized more or less frequently by (1) different species of lung worms (*Strongylus micrurus*) in cattle, roebuck and fallow deer; *S. filaria* in sheep and goats; *S. paradoxus* in hogs; *S. commutatus* in hare and rabbits, also in sheep and goats; *S. capillaris* in sheep and goats; (2) echinococci in the form of vesicles varying in size from a pea to the fist; (3) wandering liver flukes (*Distomum hepaticum*) in cysts of the size of a hazel nut and larger, with tough, partly chondrified walls, and brown, oleaceous contents. The liver flukes which are found in the lungs are, as a rule, degenerated.

In addition to these frequently occurring parasites we occasionally observe in the lungs the larvæ of Pentastomum, *Cysticercus tenuicollis*, *C. bovis* and *C. cellulosae*: the latter, however, as a rule, only when large numbers of the parasites are present in the musculature.

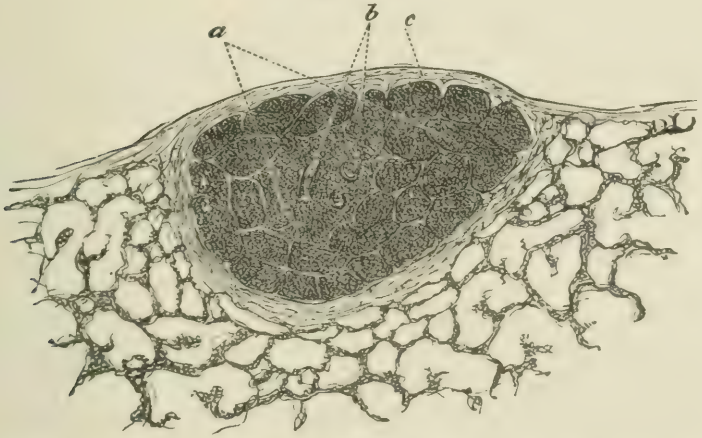
Non-glanderous pulmonary tubercles ("gray transparent," "calcareous fibrous," pulmonary tubercles).—In the lungs of horses tubercles are frequently found of an undoubted embolic character, which have given rise to confusion with pulmonary glanders. These tubercles in their early stages possess a striking resemblance to frog eggs (Csokor). Later they show a firm wall of connective tissue and a casefied or calcified content. The size of the tubercles varies. Some are barely visible to the naked eye and from this size transition sizes are observed up to that of a pea. As a rule, however, the tubercles which are found in any one lung, and which may be very numerous, are of the same size.

The tubercles in question are distinguished macroscopically from glanderous tubercles by the absence of a red zone, by their tendency to calcify, and furthermore by the homogeneous character of the tubercles, the absence of small tubercles associated with

large ones, the absence of other glanderous alterations, and by the integrity of the bronchial glands. It should be noted, however, that the tubercles in question may appear in the lymph glands.

The etiology of these non-glanderous pulmonary tubercles appears to be a variable one. In one case Martin succeeded in demonstrating fungous mycelia in the tubercles. Willach claims to have observed distomes in the pathological foci. It was demonstrated by the systematic investigation of Olt, Grips, Schütz and Künnemann, that the gray transparent and later calcareous fibrous pulmonary tubercles represent emboli or miliary chronic pneumoniæ which are produced by animal parasites, usually the larvæ of nematodes.

FIG. 80.



Entozoic pulmonary tubercles of a pneumonic form in the horse (after Olt).
a, inflamed alveoli; *b*, part of a nematode larva; *c*, connective tissue capsule of the parasitic focus. × 30 diameters.
The parts of the worms are magnified 80 diameters.

Olt found at the abattoir in Stettin that the non-glanderous pulmonary tubercles which were very frequent in that locality were caused by embolic invasion of echinococci which became prematurely disintegrated in the lumen of the blood vessels. In Pomerania, a region in which the echinococcus disease is very prevalent in man and domestic animals, seventy per cent. of the slaughtered horses, according to Olt, were infested with the tubercles in question. In further investigations, Olt demonstrated that the tubercles usually contain nematodes (probably the larvæ of *Strongylus armatus*). Concerning the seat of these entozoic tubercles, Olt maintains that they lie under the sera or in the pulmonary parenchyma, but never

upon the surface of the respiratory mucous membrane. The color of the tubercles is commonly gray or light-gray. Occasionally they are furnished with a pure white or light-yellow capsule. The most recently formed tubercles possess a reddish zone. The older ones are sharply delimited from the neighboring tissues. The consistency varies according to age. Tubercles of more recent origin constitute a thickened mass inside the otherwise normal pulmonary tissue. Later the tubercles become uniformly tough and finally present stony, calcareous kernels inside of a stratified fibrous capsule which is sharply marked off from the surrounding tissue. Parasitic tubercles which develop in the meantime in the lymph glands are distinguished by the fact that they are likewise surrounded by normal glandular tissue and never cause acute lymphadenitis, indurations, or ulcerative processes.

Schütz repeatedly inoculated the tubercles in question into rabbits and horses without producing glanderous infection in any case. Künnemann and Tröster obtained the same negative results in inoculation experiments with guinea pigs and cats. Moreover, Schütz made a microscopic examination of the gray transparent tubercles and pure cultures without finding any glanders bacilli. On the other hand, Künnemann, in accord with Olt, found that nematodes are occasionally present in the tubercles.

For the microscopic differential diagnosis of entozoic and glanderous tubercles in the lungs of horses, see under "Glanders."

Finally, attention should be called to other alterations which are caused by certain processes during the act of slaughter or during the death struggle; viz., aspirations of stomach contents and so-called blood aspiration.

Aspiration of the Stomach Contents.—During the act of slaughter, the contents of the stomach may pass into the pharynx and thence by violent inspiration may be drawn into the trachea and bronchi.

Aspiration of the stomach contents is most frequently observed in the lungs of cattle. This fact depends upon the peculiar position and character of the esophagus, in consequence of which the stomach contents of recumbent animals must from mechanical reasons pass into the esophagus. The regurgitation of the stomach contents into the esophagus is increased by trampling upon the abdomen, as is practiced by butchers in accelerating the flow of blood.

In slaughtering by the Jewish method, the stomach contents flow directly from the esophagus into the trachea, since both organs

are severed simultaneously. A portion of the stomach contents is therefore almost always found mixed with blood in the lungs of animals slaughtered in this manner. This result is brought about partly by the fact that after the throat is cut the inspirations persist for some time with undiminished force. The material which flows into the trachea is violently drawn into the ramifications of the trachea and may be so firmly wedged in the bronchial tubes that it can not be driven out again by expiration. The aspirated stomach contents may thus lead to agonal emphysema, in consequence of the obstruction of the air passages.

Recognition.—Aspiration of the stomach contents may be easily recognized by making a cross section of the lungs below the bifurcation of the trachea.

Judgment.—Lungs containing aspirated stomach contents are highly unfit for food and are to be excluded from sale if the abnormal contents are not confined simply to the trachea and larger bronchial tubes, so that the foreign material may be entirely removed by cutting open these tubes.

On account of the frequency of the occurrence of aspirated stomach contents in bovine bronchi, meat dealers, by means of knobbed scissors, commonly open and clean these structures in the preparation of the lungs.

Aspiration of Blood.—So-called blood aspiration in the lungs occurs during slaughter in cases where the trachea and the blood vessels of the neck are severed. The blood may thus be drawn into the finest bronchial ramifications as long as the animal continues to breathe.

Blood aspiration is observed most frequently in cattle and hogs killed by the Jewish method. To be sure, the latter animals are stunned before sticking and inspiration during bleeding is therefore less frequent. Nevertheless, as shown by W. Eber, a phenomenon analogous to blood aspiration is frequently observed in hogs, but this depends on the peculiar method of bleeding hogs. The blood of hogs is a valuable material; so valuable, indeed, that the blood of cattle is falsely substituted and sold as hog blood. The blood of hogs, therefore, is carefully collected and the butcher closes the wound in the skin in order to prevent the loss of the blood when the vessel utilized for receiving it becomes full. By thus pressing the lips of the wound together the blood which flows from the severed cervical vessels is forced toward the point of least resistance—being in this case the partly severed trachea—and may thus pass

into the trachea and bronchi merely from gravity and without assistance from respiratory movements. The blood does not flow out again from the trachea, since the inter-annular bands are injured in cutting in such a manner that they open only inward, like valves.

Recognition.—The aspiration of blood in cattle and the analogous phenomenon in hogs are characterized by the appearance of red-colored lobuli scattered everywhere throughout the pulmonary tissue; but, as a rule, in such a manner that they are separated from one another by portions of the lung of a normal color. In this way blood aspiration is distinguished from hypostasis. Blood aspiration is easily distinguished from lobular pneumonia by the fact that in the former the red-colored lobuli do not project beyond the surface of the lung, and feel, not like hepatized areas, but almost like normal pulmonary tissue; and, finally, by the fact that upon section the bronchi and bronchioles appear to be filled with coagulated or non-coagulated blood, while the pulmonary tissue itself is still filled with air (presence of foam in stroking the cut surface). W. Eber found that in blood aspiration the blood in the lungs undergoes partial resorption. In aspiration of blood, a red coloration of the cortical zones of the bronchial glands is frequently observed and is due to the accumulation of resorbed red blood corpuscles.

Judgment.—In moderate aspiration of blood, the lungs are not to be condemned, while in excessive aspiration they are to be considered as unfit for food, particularly because they decompose more rapidly than normal lungs.

For the recognition of artificially inflated lungs, see Chapter XV.

(d) Pleura.

The pleura exhibits only a few independent alterations. The majority of these alterations depend upon abnormal conditions and processes in the lungs. This is especially true of inflammation of the pleura.

Inflammations.—Only three forms of primary pleuritis are observed in food animals. One form is caused by foreign bodies which penetrate the thoracic cavity from the stomach; a second form of primary pleuritis develops in consequence of fracture of the ribs. The third form is of infectious origin and occurs only in hogs; it has a chronic character and is ushered in with multiple formation of abscesses (see "Infectious Pleuro-peritonitis of Hogs").

All other pleural inflammations develop secondarily in association with pneumonia.

Primary inflammations of the pleura of food animals are, in general, benign affections. They usually do not cause death or forced slaughter and are thereby essentially different from similar peritoneal inflammations. Traumatic inflammation of the pleura as well as that caused by fracture of the ribs without complication heals in the majority of cases by proliferation of connective tissue at the point of irritation after the formation of the fibrinous or serofibrinous exudation. In slaughtering animals we often unexpectedly find evidences of such inflammation in connective tissue capsules and adhesions extending from the folds of the pleura. Even the specific alterations of infectious pleuritis of hogs are, as a rule, discovered unexpectedly in animals which showed no symptoms of the disease during life.

The secondary inflammations of the pleura in pneumonia of horses and cattle, hemorrhagic septicemia of cattle, and swine plague, run exactly the same course as that of primary pneumoniæ. It is only in case of necrosis of superficial portions of the lungs that putrefactive and septic bacteria from the outside world may gain entrance to the pleuritic exudation and thereby cause the complication of sapremia and septicemia. In the majority of cases the pleuritic process heals simultaneously with the pneumonia and leaves only such connective tissue adhesions as, for example, are so frequently observed in hogs after recovery from swine plague. In consequence of the connective tissue adhesions, pulmonary abscesses which extend to the surface may be prevented from opening into the pleural cavity and may be rendered harmless to the organism after complete encapsulation.

The anatomical forms of pleuritis are the same as those of peritonitis. Judgment on them should be governed, therefore, by the same rules as judgment of peritonitis.

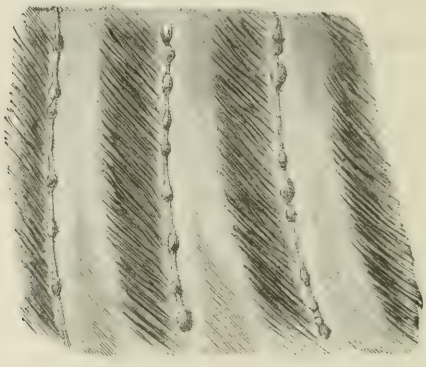
Beside inflammations, the following alterations of the pleura deserve consideration:

Hypostasis.—In natural death and in slaughtering during the crisis of disease, hypostatic congestion appears on the low-lying parts of the pleura in the same manner as in the lungs. The red coloration of the pleura, however, which may appear when the blood passes into the pleural sac during bleeding, must be distinguished from hypostasis. In the former we find small and large blood clots on the pleura and a diffuse red coloration of this structure.

Tumors.—In addition to sarcomata, false neuromata of the intercostal nerves (myxo-fibromata) may occur quite frequently under the pleura of cattle. These neomorphic structures occupy a position corresponding to the course of the intercostal nerves in the intercostal spaces underneath the pleura. They are conspicuous, therefore, when they occur in large numbers, for their regular arrangement.

False neuromata of the intercostal nerves in their early stages may be confused with tuberculosis and in their later stages with echinococci. At first they form gray, firm tubercles varying in size from a hemp seed to a pea and surrounding the nerve like a ring (Fig. 81). In the large tubercles—they sometimes reach the size of

Fig. 81.



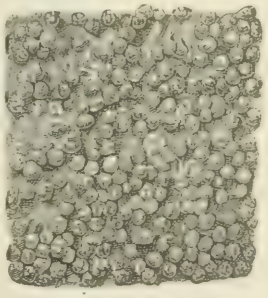
False neuroma of the intercostal nerves in cattle.

a potato—the myxomatous tissue is more conspicuous. In this manner structures arise which, to the naked eye, possess great resemblance to echinococci. Section, however, immediately demonstrates to the inspector the true nature of the alteration, for only a slight quantity of slime-like tissue and no fluid oozes from the spherical or elongated structures. Myxo-fibroma of the intercostal nerves is distinguished by the complete absence of caseation.

False neuromata of the intercostal nerves are but rarely observed in slaughtered cattle. Moreover, they exercise no influence over the character of the meat. It is necessary merely to remove them and this may be done in connection with the nerve strands.

Infectious Granulations.—In cattle, tuberculosis of the pleura is of unusually frequent occurrence. In hogs it is very rare. Pleural tuberculosis of cattle begins with proliferation of small red connective tissue papillæ and filaments which give the pleura a velvety appearance. Later, casefying and calcifying tubercles are observed in the larger connective tissue proliferations (Fig. 82). Pleural tuberculosis is also characterized in the advanced stages by the strongly developed connective tissue framework of the tubercle. Tuberculous neomorphs on the pleura may reach a considerable thickness (up to 20 cm. and over), and this without the subjacent parts, ribs, and intercostal muscles showing even the slightest trace of disease *per continuitatem*. This is of the greatest importance in rendering judgment on serous tuberculosis with reference to the neighboring musculature. Attention should again be called to the fact that the corresponding lymph glands of the pleura are the retro-pleural, thoracic and mediastinal, and not, as has been erroneously assumed, the lymph glands of the anterior extremity, axiliary and prescapular glands.

Fig. 82.



Serous tuberculosis of cattle (pearl disease).

We should not confuse incipient pleural tuberculosis with proliferating inflammations of the pleura which develop from friction from echinococci, and which extend to the pleura.

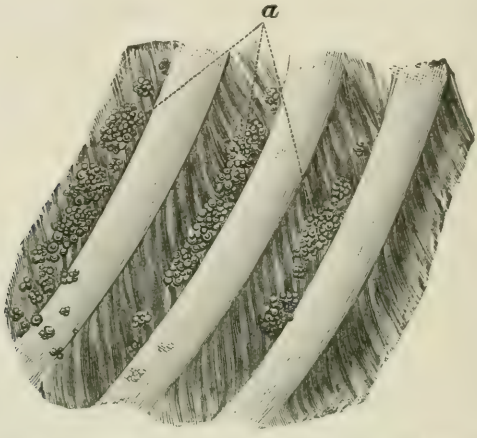
Besides tuberculosis, actinomycosis may exceptionally occur on the pleura of cattle. The infection arises either from the lung or, in pleura phrenica, from the liver. In the latter case actinomycotic tissue penetrates the diaphragm. When all other characters are disregarded, actinomycotic tubercles are distinguished by the soft, myxoma-like oozing surface on section, showing numerous yellow granules, as well as by the strongly developed neomorphs of connective tissue in the neighborhood of all other similar alterations.

In chickens and pheasants, the air sac mite (*Cytodites nudus*) is frequently found in the air sacs of the thorax, neck and abdomen. The mites are visible to the naked eye as yellowish or brownish points. They may cause inflammatory alterations of the membranes of the air sacs in the form of yellow gelatinous effusions or membranous deposits (Kitt). In cases of extensive invasion of the lungs and trachea, death may result from inflammation of these air pas-

sages and from asphyxiation (Gerlach, Zschokke, Megnin). Holzendorff also found the mites in miliary abscesses of the liver, lungs and kidneys of chickens.

Parasites are only occasionally found in the sub-pleural tissue. In one instance the author found under the pleura of a hog an *Echinococcus multilocularis* which presented the appearance of

Fig. 83.



a. Echinococcus under the costal pleura in a hog.

tuberculosis (Fig. 83). A similar case was recently observed by Benedictis in cattle. The dangerous cysticercus of cattle and hogs has a special predilection for the intercostal muscles which are covered by the pleura.

5.—Circulatory Apparatus.

(a) Heart.

In the heart the following parts require special discussion : The epicardium with the pericardium ; the inner lining of the heart (endocardium) ; the cardiac muscle (myocardium).

Epicardium and Pericardium.

Hemorrhages.—The epicardium is frequently the seat of petechiæ which appear as sympathetic symptoms of toxic, infectious, general diseases under the serous membranes. For example, in anthrax, Texas fever, and fowl cholera, the epicardium shows black

spots or petechiæ in an almost pathognomonic manner. Large quantities of blood are found in the pericardial cavity in rupture of the heart, or of the coronary artery.

Inflammations of the pericardium arise primarily from wounds. Furthermore, they may develop secondarily under the same conditions which cause secondary pleuritis. In the latter case, the inflammation of the pericardium represents merely a complication of primary pulmonary inflammations. Traumatic pericarditis is a typical disease of cattle. It will be discussed in greater detail under "Sapremia." It should be noted that occasionally in hogs a serous or sero-fibrinous pericarditis is observed as the only phenomenon of swine plague. More frequently, however, a simultaneous inflammation of the pleura and lungs is observed.

Connective tissue proliferations of the epicardium and of the inner layer of the pericardium, sometimes leading to adhesions of these parts, are observed after recovery from acute pericarditis. This condition is most frequently observed in hogs after swine plague and in cattle after recovery from traumatic pericarditis.

Connective tissue adhesions between the epicardium and the inner layer of the pericardium interfere with a careful inspection of the surface of the heart, especially for cysticerci. In inspecting the heart, it is therefore desirable to remove the pathologically altered epicardium with a knife.

Tumors.—Tumors may project into the pericardial cavity either from the pericardium or from the epicardium. According to Kitt, fibromata and fibro-sarcomata occur most frequently.

Infectious Granulations.—Among the specific neomorphic formations, tuberculosis of the pericardium is of frequent occurrence in cattle. The pericardium as well as the pleura and peritoneum may apparently be affected with primary tuberculosis. Ordinarily, however, tuberculosis of the pericardium is associated with pulmonary and pleural tuberculosis.

When the epicardium is affected, it is a striking fact which is sufficiently explained by the centripetal course of the lymphatic vessels that even the most serious cases of epicardial tuberculosis begin with complete integrity of the myocardium.

Endocardium.

The inner lining of the heart may exhibit petechiæ under the already frequently noted conditions, and also insignificant cloudiness

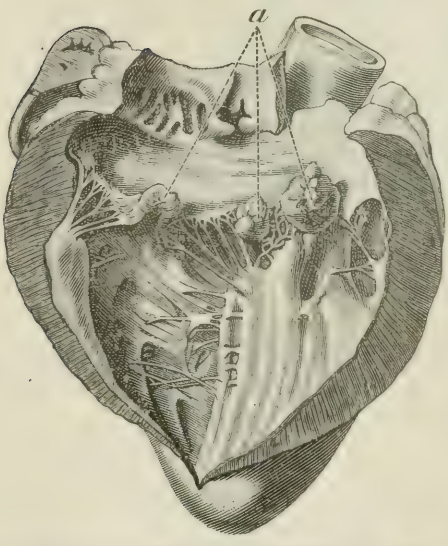
in consequence of partial fatty metamorphosis or proliferating inflammation.

According to Glage, cysts varying in size from a pea to a bean and resembling cysticerci occur quite frequently on the auriculoventricular valves in hogs. Gibson also observed similar cysts in sheep.

For the differential diagnosis of endocardial petechiæ, attention should again be called in this connection to the systolic hyperemic conditions of the myocardium and to the valvular hemorrhages in fasting calves (compare page 174).

Inflammations.—Inflammations of the duplicatures of the endocardium or the so-called cardiac valves are not without importance for meat inspection. Two forms are distinguished: Verrucose and ulcerous valvular endocarditis. Verrucose valvular endocarditis may reach such a condition that the death of the animal is brought about by mechanical obstruction of the circulation. Furthermore, thrombi may be formed upon the greatly thickened cardiac valve so as to exercise the same influence upon them as strong connective tissue proliferations upon the valvular apparatus. With regard to the etiology of the verrucose form of valvular inflammation, it may represent a simple proliferating inflammation or an infectious process. Cocci and bacilli have been found in the proliferating valves. A special and frequent form of infectious verrucose valvular endocarditis is caused by the bacillus of swine erysipelas (Fig. 84).

Fig. 84.



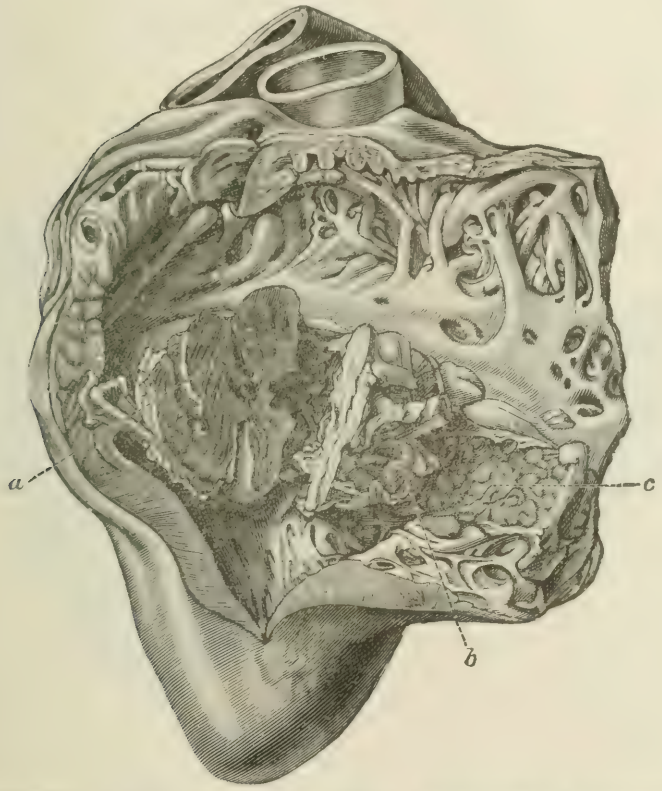
Heart of a hog with valvular verrucose endocarditis as a sequela of swine erysipelas. *a*, warty thickenings.

Ulcerous or diphtheritic valvular endocarditis begins with a desquamation of the superficial layers of the cardiac valves. Later the desquamating areas are modified into ulcers. Large thrombi arise in the ulcerous spots (Fig. 85). The loosening of the thrombi

may give rise to hemorrhagic infarcts in the liver, lungs, spleen and kidneys.

Ulcerous inflammation of the cardiac valves is either of toxic or infectious origin. In the latter case pyogenic organisms are of special importance. For this reason ulcerous valvular endocarditis may serve as a starting point in pyemic processes (see under "Pyemia").

FIG. 85.



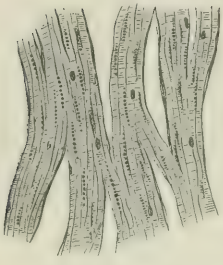
Beef heart with valvular ulcerous endocarditis. *a*, cut surface of the thrombus on the ulcerous cardiac valve; *b*, base of the thrombus after artificial separation from the substratum; *c*, ulcerous part of the cardiac valve.

TUMORS.—Tumors of the character of fibromata and fibrosarcomata may arise upon the endocardium as well as on the pericardium and epicardium. According to Kitt, the tumors take their origin from the sub-endocardial tissues, are commonly pedunculate, and connected with a trabecula, papillary muscle, or tendon. Tumors which project into the cardiac cavity may reach the size of the fist.

Myocardium.

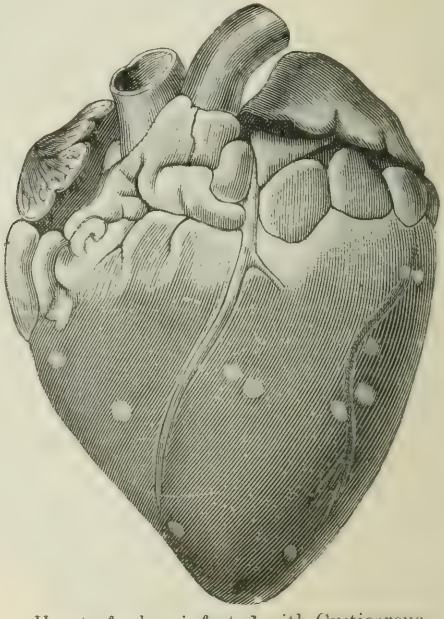
Dissolutions of Continuity in the myocardium cause death. They are produced by injuries from the outside (stabs and shot wounds) and by spontaneous rupture. Spontaneous rupture is observed as a sequela of fatty metamorphosis of or infestation of the myocardium with parasites (echinococci). In old horses, atheromatosis of the auricles sometimes leads to rupture of the heart. Death occurs from hemorrhage into the pericardium.

Fig. 86.



Incipient fatty metamorphosis of the cardiac muscle.

Fig. 87.



Heart of a hog infected with Cysticercus cellulosæ.

Degenerations.—The most important alterations of the myocardium are cloudy swelling and fatty metamorphosis (grayish-red or grayish-yellow discoloration, cloudy and soft, friable consistency). Both forms of degeneration arise under the same conditions as those of the liver and kidneys.

Circulatory Disturbances and Inflammations.—Embolic infarcts are observed in the myocardium in malignant foot and mouth disease of cattle (Johne). Müller observed a case of the formation of multiple abscess in the myocardium of a cow which, one year

previously, suffered from an acute attack of foot-and-mouth disease. Metastatic abscesses may develop in the myocardium in association with other processes which are ushered in with suppuration. This is quite frequent in cases of metritis and is occasionally observed also in consequence of contagious coryza and suppurative omphalophlebitis (Kitt). The abscesses may also arise from necrotic foci in the myocardium which are due to embolic transportation of the necrosis bacilli (Bang and the author).

Infectious Granulations.—In rare cases tuberculosis of the myocardium develops in food animals. In the few cases which have been seen by the author, the tuberculous areas exhibited the characteristic form of hemorrhagic infarcts.

Parasites.—In the myocardium there is frequently observed injurious cysticerci, especially *C. bovis* in cattle and *C. cellulosæ* in hogs and sheep. The parasites show a predilection for a position under the epicardium and endocardium. They may, however, penetrate the whole musculature of the heart. Furthermore, echinococci are occasionally met with in the myocardium. They may occasion sudden death by rupture of the connective tissue capsule and the escape of the encysted worms into the ventricles. Large echinococci, however, may, in and of themselves, and without rupture of their capsules, produce threatening symptoms and sudden death from cardiac paralysis, especially when they have their seat in the septum of the heart.

(b) Blood Vessels.

As a noteworthy local disease of the blood vessels, attention should be called to verminous aneurisms of the branches of the abdominal aorta, especially of the trunk of the anterior mesenteric artery in the horse. This verminous aneurism, which, as is well known, is caused by *Strongylus armatus*, may reach quite considerable proportions without causing any disturbances in the health of the horse. Occasionally a fatal hemorrhage is observed in consequence of the rupture of the wall of the aneurism.

Calcification is sometimes observed in the aorta of cattle. The intima of the vessel, which is distinguished by its inflexibility, is permeated with cloudy-white, sharply-delimited, leaf-shaped deposits of lime, the middle portion of which is concave. Rough, sand-like deposits may exist at the same time (Kitt). For purulent inflammations of the walls of the blood vessels, see under "Pyemia."

6.—Lymphatic Glands.

The lymphatic glands have an important physiological rôle. They act as a filtering apparatus and thereby purify the lymph stream from admixtures of foreign substances before it passes into the blood circulation. The larger corpuscular elements are certainly filtered out of the lymph. The filter is likewise effective even for bacteria, in different degrees in different animals. Thus, in cattle and hogs the lymph glands may for a long time restrict a tubercular process to the point of origin and prevent an infection of the blood. Pyogenic bacteria are also prevented from entering the blood circulation by the lymph glands of food animals. In the smaller animals—for instance, in the experimental animals of the laboratory—this protective function is much less effectively performed.

Inflammations.—The lymph glands react very readily to irritation. They are therefore regularly inflamed when inflammatory processes occur in their tributary area. In ordinary inflammatory swelling, the lymphatic glands are enlarged and on cross section more fluid exudes. In more advanced stages of lymphadenitis, hemorrhages into the tissue of the lymphatic glands are associated with the original process (hemorrhagic lymphadenitis).

A swelling of all the lymphatic glands is observed in acute infectious diseases and in chronic diseases which have become acute ; for example, in sepsis, pyemia, and chronic tuberculosis after the entrance of the tubercle bacilli into the blood.

Inflammations of the lymphatic glands usually disappear as rapidly as they arise. Yellow-colored spots may remain as evidence of the hemorrhages which sometimes accompany inflammations.

Specific Alterations.—In contrast with simple adenitis as a sequela of ordinary inflammatory processes, all inflammations of other sorts are due to the effect of specific pathogenic microorganisms. Thus, indurating lymphadenitis is produced by the glanders bacillus, lymphadenitis with abscesses by the streptococci of contagious coryza ; casefying lymphadenitis by the bacilli of tuberculosis, pseudo-tuberculosis, and hog cholera. The ray fungus (*Actinomyces bovis*) produces in domestic animals no true inflammation, but simply typical granulations in lymphatic glands. It is of special importance in making a differential diagnosis to

know that purulent processes in domestic animals are not capable of producing suppurations in the lymphatic glands and that caseation of the lymph glands, the important criterion in tuberculous processes, occurs only in tuberculosis, pseudo-tuberculosis and hog cholera.

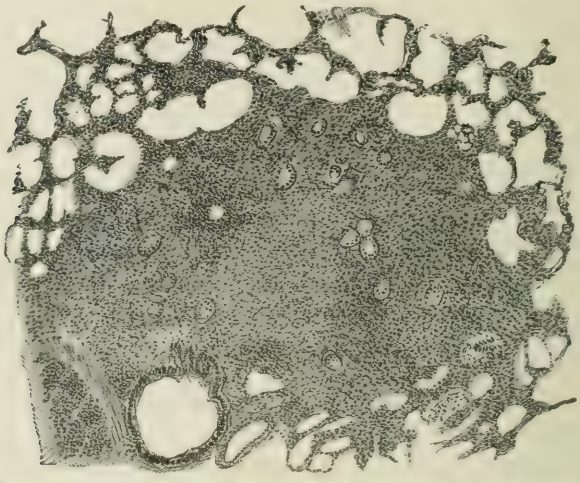
In glanderous lymphadenitis, tubercles are found in the swollen lymphatic glands which disintegrate in the center and become caseified but not calcified (Csoker, Kitt and Schütz). Glanderous lymph glands, according to Schütz, become enlarged at first and shiny on cross section, with a reddish or pale-gray color; later they become somewhat dryer and of a more velvety or roughish feel upon cross section. The size of the swollen gland does not exceed that of a walnut or plum, as a rule. A whole cluster of lymph glands is rarely affected. As a rule, the glanderous alterations are restricted to a portion of the lymph glands. The lymphatic glands are penetrated by callous-like, white, connective tissue strands which project inward from the thickened capsule. On cross section there appear indistinctly marked, small, grayish-yellow and yellow spots which lie very close to one another, or scattered in the glandular tissue. These spots in cases of fresh infection are often difficult to recognize. They present in such cases minute particles with a puriform disintegration. If the alterations are of longer standing, the spots become cloudy, white, dryish, caseous and mortar-like. Simultaneously the induration and cicatricial contraction of the newly formed connective tissue proceeds in the lymphatic glands, and the cloudy deposits, which often possess an angular form, appear like foreign particles which have been inserted into the cicatricial mass. Total caseation of the lymphatic glands does not occur in glanders, according to Schütz. Exceptionally, in consequence of glanderous infection, they may be modified into white, callous, bacon-like masses of the size of a goose egg, which inclose cavities containing an oily, fluid, gray pus (Kitt).

In actinomycosis of the lymphatic glands, a macroscopically-visible, roughened, hard character of the lymphatic glands is observed. Under the microscope, on the other hand, a uniform accumulation of the epithelioid and giant cells is observed around the mycelium of the ray fungus.

Finally, in tuberculosis, which is the most important disease of the lymphatic glands in meat inspection, there is at first a simple swelling, enlargement and increase in the fluid content; then minute tubercles, which are distinguished from the surrounding tissue by their gray color, are demonstrable. Later, larger, round tubercles

are found, the centers of which appear to be cloudy in consequence of caseation. (Compare Fig. 76, *a* and *b*). And, lastly, a calcification usually appears in the place of the caseation. The individual foci either remain separated or fused together. In the first place, isolated tubercles are observed in the lymphatic glands, and in the latter case a uniform replacement of the normal tissue of the lymphatic glands by casefied or calcified masses. Calcification may progress so far that the lymphatic glands can no longer be cut with a knife. At the same time the lymphatic glands are enlarged to twenty or more times their original volume.

Fig. 88.



Miliary tubercle with numerous giant cells, × 75 diameters.

Diagnosis of tuberculous alterations in the lymphatic glands.—In the practice of meat inspection, one sometimes makes the highly astonishing observation that only those glands which are casefied and calcified are considered and treated as tuberculous. The danger to the public from such a method of treatment is evident from the preceding discussion, without further argument. The incipient swellings of the lymphatic glands with eruption of minute tubercles are more dangerous than the old alterations in which calcification has already occurred. The experienced inspector readily distinguishes macroscopically and with certainty simple lymphadenitis from tuberculous swelling. In the former the color of the cut surface is usually white; in the latter, more grayish. Furthermore, the author has found that an examination of the cut surface

with a hand lens may offer much assistance in the establishment of a diagnosis (recognition of minute tubercles). A still better procedure, however, consists in an examination of a teased preparation from the suspected lymph glands with a magnification of about forty diameters (the author). It is thereby possible in cases of simple hyperplasia to observe a uniformly transparent tissue. In tuberculosis, on the other hand, transparent tissue is represented by cloudy areas which, as a rule, appear roundish and under a somewhat greater magnification exhibit in their interior necrotic giant cells in the form of dark, roundish or oval structures (Fig. 8). For details on this point and on the important differential diagnosis, from a sanitary standpoint, between the alterations in tuberculosis and in hog cholera in the lymphatic glands, see under "Tuberculosis."

Tumors.—Sarcomata, carcinomata, and so-called lymphomata occur in the lymphatic glands. The latter are the most important tumors of the lymphatic glands in so far as their frequency and significance in meat inspection are concerned.

Sarcomata may develop primarily in the lymphatic glands. Carcinomata, on the other hand, always penetrate into the organs in question in consequence of metastases. Lymphomata are distinguished as soft and hard. We are chiefly interested here with soft lymphomata on account of their frequent occurrence in food animals. They represent soft, "almost fluctuating" tumors which may attain an enormous volume (the size of a man's head and larger). Under the microscope, one finds the same elements which are present in the normal lymphatic gland. It is noteworthy that soft lymphomata may occur simultaneously in a number of lymphatic glands, also in the lymphatic follicles of different organs, in the spleen, and, in young animals, in the thymus. On the other hand, organs which do not belong to the lymphatic apparatus, like the liver and kidneys, may be affected with lymphomata by metastasis.

Soft lymphomata are a symptom of constitutional disease. According as the blood is affected or not, we speak of leukemic lymphomata in cases of pronounced leukemia (increase in the number of white blood corpuscles), or of pseudo-leukemia (Cohnheim), in cases where the blood shows no alteration in the numerical relation between the red and white blood corpuscles. For judgment, see under "Leukemia" and "Pseudo-leukemia."

Parasites.—Among the animal parasites, there frequently occur, in the lymphatic glands, pentastomum larvæ (mesenteric glands), more rarely cysticerci (in cases of excessive invasion), and, occasionally, echinococci. All three parasites may become casefied and calcified. In this condition the alterations of parasitic origin may be confused with tuberculosis. Casefied parasites, however, may be easily distinguished from tuberculous areas by simple microscopic examination (a teased preparation with a slight magnification). During this examination one finds in the parasitic alterations either the whole body of the worm or characteristic portions of it, viz.: claws in the case of pentastomes, and calcareous bodies in the case of cysticerci; (in the case of C. cellulosæ, also, hooks); and striated portions of membranes in the case of echinococci. Leuckart reports the finding of a round worm larva in the mesenteric glands of a beef animal. The parasite was surrounded by a connective tissue capsule and lay rolled up in it.

7.—Spleen.

The serous peritoneal covering of the spleen may exhibit the same alterations as the peritoneum. In tuberculosis, the peritoneal covering of the spleen is often more decidedly affected than the remainder of the peritoneum.

The parenchyma of the spleen is the site of various important alterations. We find in the splenic parenchyma metastatic tumors (sarcomata and carcinomata), leukemic and pseudo-leukemic enlargement of the follicles, metastatic abscesses (in pyemia), and embolic masses of roundish form and varying size in tuberculosis and glanders. Among the animal parasites, the spleen may be infested with echinococci, wandering liver flukes in cysts, as in the lungs, and pentastomum larvæ.

The most important alteration of the spleen is acute splenic tumor. This is pathognomonic for Texas fever, anthrax and swine erysipelas. To a lesser extent, splenic tumor may appear also in other infectious diseases. In these cases, however, it possesses less significance than in Texas fever, anthrax and erysipelas.

A considerable increase in the volume of the spleen, which may be confused with infectious splenic tumor, arises in consequence of the multiple formation of infarcts in the branches of the splenic artery. The inciting cause to this condition is found in endocarditis. An infarct in the spleen consists, as in the case of a renal or pulmonary infarct, of round or wedge-shaped masses which are at first

dark-red, but later appear yellowish or white in consequence of a modification and resorption of the coloring matter of the blood. The infarcts of the spleen are raised above the surrounding tissue in the form of a tumor. In cases of occlusion of several small branches or one large arterial branch, the spleen may enlarge to two, three, or more times its normal size. The sequela of such an extensive formation of infarcts is usually a considerable shrinking of the spleen after the necrotic infarcted masses have been resorbed.

The essential characteristics of splenic infarcts are the round or wedge-shaped contour, harder consistency, and discoloration of the delimited areas—an evidence of embolic, thrombic occlusion of individual branches of the splenic artery.

Alterations similar to those caused by the formation of hemorrhagic infarcts may occur in hogs in consequence of a rotation of the spleen around its longitudinal axis (Glage). The spleen in hogs is, as an appendix to the large omentum, not so securely fixed in its position as is the spleen of cattle and sheep. If the spleen is rotated in consequence of external agencies or variations in the degree of fulness of the internal organs, violent stoppage of the circulation in the spleen may occur in consequence of torsion of the splenic blood vessels. This is most likely to occur in old animals with ligaments devoid of fat. If the spleen remains in its abnormal position, thrombosis occurs in the vascular trunks of the ligaments at the point of torsion and consequently at first an anemic necrosis, and later, after resorption of the disintegrated mass, a shrinking of the spleen, as in the case of the formation of infarcts.

As a means of distinguishing between splenic tumor due to torsion and infectious tumor in anthrax, Glage considers it an important fact that in torsion of the spleen the pulp of the organ, in spite of its high blood content, is not softened.

In hogs, as a sequela of the above described alterations, we frequently find completely shrivelled spleens with organized thrombi in the splenic artery. In such cases, which are otherwise without significance for meat inspection, we may occasionally observe a new formation of small accessory spleens on the omentum.

T. Adam observed swellings in the spleen up to four times its original volume in cattle which before slaughter appeared to be in perfect health. Adam suspected a horn thrust as the cause. Perhaps, however, they were cases of physiological swelling in animals which had been fed and watered immediately before slaughter (compare page 170); for, after traumatic injuries, extensive hemor-

rhages may occur in the tissue of the spleen, but not a uniform swelling of the spleen.

With reference to chronic splenic tumor in leukemia and pseudo-leukemia, compare page 371.

8.—Nervous System.

(a) Central Nervous System.

The diseases of the central nervous system, brain and spinal cord are of slight importance from a sanitary police standpoint, for they do not lend the meat of animals any dangerous property. The only diseases of interest in this connection are wounds, inflammations, tumors and parasites of the organs of the central nervous system as causes of natural death or emergency slaughter.

Brain.

Of the pathological processes in the brain, the more important are acute meningitis and hydrocephalus chronicus, as well as so-called cholesteatomata on the basis of the cranium and in the ventricles; abscesses in consequence of contagious coryza; meningeal tuberculosis, which appears in the form of tubercles from the size of a millet seed to that of lentils in the pia mater, especially at the base of the brain, and may be ushered in with inflammatory symptoms (tuberculous, basilar meningitis); also *Cœnurus cerebralis* and occasionally echinococci, *Cysticercus bovis* and *C. cellulosæ*. The last two parasites are occasionally found in the brain, even when the musculature shows only a slight invasion. Acute meningitis, meningeal tuberculosis, and *Cœnurus cerebralis*, as a rule, produce such serious motor disturbances that an inspection of the living animal indicates pathological processes in the brain.

Spinal Cord.

In the spinal canal of cattle, in regions where grazing herds are regularly infested with warble flies, the young larvæ of œstrus very frequently occur, according to the investigations of Hinrichsen. This author found the larvæ in from 40 to 50 per cent. of all cattle which grazed on pasture during the summer. The larvæ are from 5 to 13 mm. long, 1 to 2 mm. wide, are located in the subdural adipose tissue, and have been found isolated or in numbers up to forty or more. In the months of December to March, these parasites

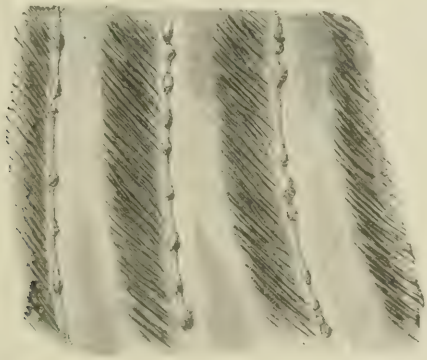
may be demonstrated much more frequently in the spinal canal than in other months. Koorevaar observed œstrus larvæ especially abundant from October to January in the subdural fat tissue, while they appeared to be absent from April to September.

In sheep, cœnurus bladders may occur in the spinal cord and may produce the clinical symptoms of so-called turn sick.

(b) Peripheral Nerves.

In certain peripheral nerves we observe, as was already stated on page 334, tumor-like thickenings in consequence of fibrous or myxo-fibrous neomorphs (Fig. 89). The differential diagnostic value of these myxo-fibromata on the intercostal nerves has already

Fig. 89.



False neuroma of the intercostal nerves in cattle

been discussed elsewhere. We should mention the plexiform neuromata which are occasionally found in cattle on the facial nerve and brachial plexus. These neuromata, when extensively developed, penetrate the intercostal muscles and may then be recognized in the ordinary inspection of slaughtered animals without separating the anterior extremity.

9.—Skeleton.

In the bony framework of food animals there may occur general diseases and alterations which are restricted to the bones.

(a) General Diseases.

The most important general diseases of the bony skeleton are rachitis, osteomalacia and osteomyelitis. The last named disease is a special form of pyemia and will be discussed, therefore, under that head.

Rachitis.—This is a disease of young animals and among food animals is most frequently observed in hogs. It consists in an extensive proliferation of the cartilaginous epiphyses and in a prolonged condition of softness in the growth of new-forming bone, a process which is explained by defective deposition of lime. The consequences of this disturbance in the growth of the bones are the well-known swellings and curvatures in the skeleton.

Judgment.—According to all experience and according to the present status of our knowledge concerning the nature of rachitis, the meat of rachitic animals can not be regarded as injurious. However, the meat of animals which are affected with rachitis of the whole skeleton and not one or several bones, as in the snuffle disease, is to be excluded from the market for the reason that in acute stages of the disease serious internal disturbances, even cachexia, may be ushered in.

Osteomalacia, friability of the bones, in contrast with rachitis, is a disease of old age. It is to be considered as calcareous inanition. The essential symptom of osteomalacia consists in a decalcification and progressive attenuation of the compact cortical substance of the bones in consequence of resorption. An abnormal softness and friability is thereby produced, and, as a rule, it is bone fractures which lead to a recognition of the disease and to emergency slaughter of osteomalacic animals. Multiple fractures of the pelvis are especially frequent. Maris counted fifteen fractures in the pelvis of a cow. The bone marrow in osteomalacia is dark, yellowish-red and of a more or less fluid consistency (fluidity of the marrow). Moreover, the spongy portion of the bone is rich in blood and is, therefore, dark-colored and softer than normal. Finally, the periosteum is readily separated from the bones. During life one may observe in animals with friable bones a difficulty in getting up and a straddling gait.

Judgment of the meat is determined according to the character of the latter. So long as emaciation does not exist, the meat may be permitted to go upon the market without restriction, provided

that no wound infection has developed at the point of fracture of some broken bone. In case, on the contrary, emaciation has already set in, the meat is spoiled (of inferior value), and if cachexia is present, it is highly unfit for food. In the latter case the fat marrow of the tubular bones disappears and is replaced by gelatinous, so-called jelly, marrow.

(b) Local Diseases.

Fractures.—These are of frequent occurrence in food animals and are observed especially in highly fattened hogs in the tubular bones of the posterior extremities. Moreover, fractures frequently occur in the pelvis of cows and in the ribs of all food animals.

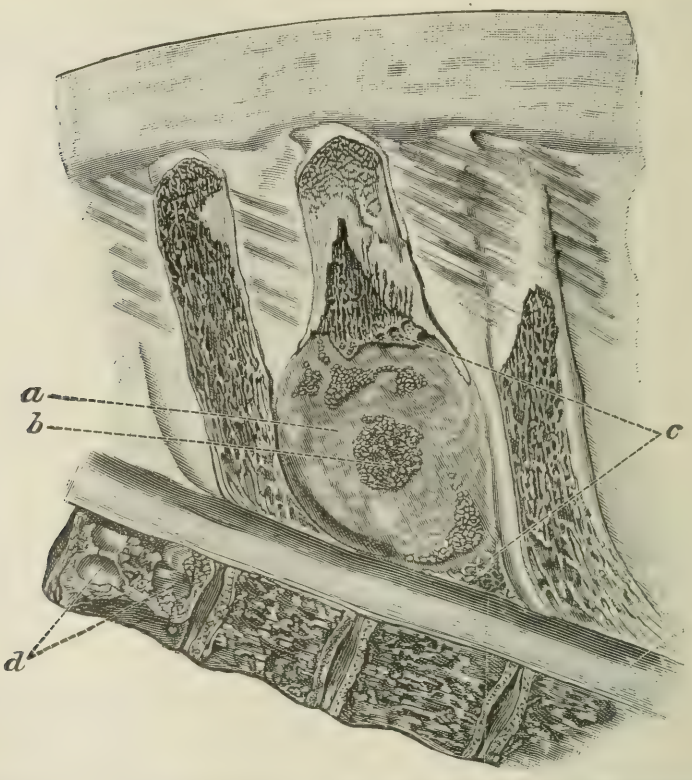
Judgment.—Fresh bone fractures lend the adjacent meat a spoiled or inferior quality in consequence of the infiltration of blood. Old, healed bone fractures, on the other hand, are without significance. In complicated fractures in process of healing (in which the skin has also suffered lesions) an examination should be made to determine whether an infection of the wound exists.

Infectious Granulations.—With the exception of fractures, the specific granulations of tuberculosis and actinomycosis are the only diseases of the skeleton of significance in meat inspection. Glanderous alterations in the bone are of no consequence from a sanitary police point of view, since they occur merely as complications of primary glanderous processes in other organs. In cases of glanders, however, the consumption of the meat is absolutely forbidden. The case is quite otherwise in tuberculosis and actinomycosis. In these diseases embolic processes in the bones of the skeleton should lead to an exclusion of the meat from market.

Tuberculosis may occur in all of the bones. Tuberculous alterations, however, are most frequently observed in cattle and hogs in the dorsal vertebra, sternum and ribs. Tuberculosis of the bones of the extremities is less frequent. An affection of these organs is indicated to the expert by specific alterations of the superior lymphatic glands of the extremities (prescapular and axillary or popliteal and inguinal glands). The diseases of the dorsal vertebræ and sternum, in the ordinary method of cutting up animals in the slaughterhouse, may be demonstrated directly, since the dorsal vertebræ and the sternum are cut through the middle with a saw or an ax, and thereby the tuberculous masses are immediately brought to view, since, as a rule, they take their origin from the middle of those bones.

The tuberculous areas appear in the form of grayish-red, soft granulations which are plainly distinguished from the surrounding bony tissue. At first, however, they are not easily separated from it (demonstration of the tuberculous nature of such small areas by means of an identification of giant cells) (see page 344). In older and larger masses which are located in sinuous cavities with smooth

Fig. 90.



Tuberculosis of the dorsal vertebræ in a hog. *a*, caseous focus; *b*, deposition of lime in the caseous focus; *c*, bony bands and islands on the border of the caseous focus; *d*, section of a vertebra after removal of the tuberculous products.

cells and which are not easily separated from these, the grayish-yellow color is more conspicuous. Furthermore, we observe in the larger masses a partial calcification which, however, is never especially far advanced. The larger masses in the bones, therefore, possess the character which has previously been designated as fungous. Tuberculous granulations may attain such a volume that finally only a seam-like residue of the normal bone tissue remains.

It should be noted that in addition to the vertebral bodies the spinous processes are also frequently affected with tuberculosis (Fig. 90).

In tuberculosis of the ribs, which never arises by an outgrowth from tuberculous processes in the pleura, but exclusively in a hematogenous manner, one observes a thickening as the first alteration. By making a cross-section through the thickened portion with a saw we may immediately become convinced of the tuberculous nature of the thickening, especially from the presence of the above-described granulations. In more acute stages of costal tuberculosis, the external layer of the bone is so attenuated that it may be cut through with a knife. This is of importance in distinguishing between costal tuberculosis and callous thickenings following fractures of the ribs.

Actinomycosis of the bones is in cattle an unusually frequent primary affection. The lower jaw is most frequently attacked. However, primary actinomycosis of the bone may occur on the upper jaw. The author observed an interesting case of primary actinomycosis of the sternum in a beef animal. In this case infection was brought about by a sharp wire which had penetrated outwardly from the stomach into the sternum. The ray fungus, by its continued multiplication, causes an enlargement and rarefaction of the bones. Simultaneously an extensive swelling and later a perforation of the bones at one or more points occur. At the points of perforation the actinomycomata project outwardly in the form of plugs. Embolic actinomycosis of the bones is of rare occurrence. Hertwig described a case of this sort in a hog. In the animal in question, in addition to primary actinomycosis of the mammary gland, softened masses of the size of a hazel nut appeared in several dorsal vertebræ. In the softened masses was found the ray fungus, the presence of which was evident in a microscopic examination, from the existence of yellowish granules.

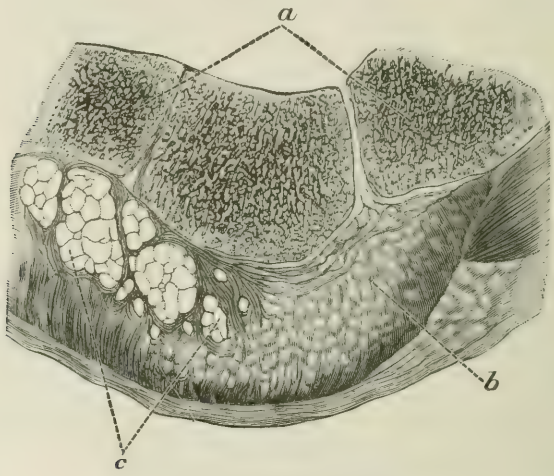
Parasites.—Exceptionally, echinococci occur in the bones. Casefied echinococci may resemble tuberculosis of the bones. The demonstration of the characteristic striated membrane of the echinococci will protect one from such a mistake in diagnosis.

Diseases of the Joints.—Local diseases of the joints do not require any special discussion. With reference to penetrating wounds of the joints and polyarthritis of sucking animals, compare the chapter on "Pyemia" and "Septicemia."

Articular tuberculosis, which is rarely met with, appears in two forms: (1) As tuberculous articular empyemia, characterized by slimy purulent exudation, and (2) as so-called fungous arthritis, in which the articular cavity is filled with tuberculous granulating tissue which grows out from the synovial membrane.

Presternal Calcification.—Underneath the sternum and sympathetically affecting this bone in part, a peculiar calcification process occurs in fattened cattle and sheep. This deserves to be mentioned on account of its scientific interest and the possibility of its being mistaken for tuberculosis. In the animals in question one observes,

FIG. 91.



Presternal calcification.
a, section of the sternum; *b*, normal sternal pad; *c*, lime deposits.

in the pad formed of elastic and fat tissue, tumors with a roughened surface and hard consistency, frequently of the size of a hazel nut or that of the fist. After making a cross-section of the sternum with a saw, it is apparent that the tumors consist of a strong connective tissue framework, in the cavities of which a pure white gypsum-like mass is deposited. This mass consists of carbonate and phosphate of lime. The periphery of the tumors is delimited by strongly-developed connective tissue. In some cases, but not regularly, the tumor penetrates into the sternum in consequence of a proliferation of the part of the sternum which is directly in contact with the tumor.

No parasitic cause has been discovered for the above described deposition of lime underneath the sternum. It has rather the appearance—and this is indicated by the exclusive occurrence of the alteration in fat animals—that it arises after a crushing of the sternal pad while the animals are lying and is due to a simple deposition of lime in the crushed parts. The enlargement and progressive character of the "tumor" might be explained by the pressure of the primary calcareous deposit upon the surrounding tissue.

10.—Skeletal Musculature.

Dissolution of Continuity.—Dissolutions of the continuity of muscles are often observed in food animals. They occur most frequently as secondary ruptures in cases of bone fractures. Furthermore, one may observe in hogs an independent rupture of the psoas muscle (from violent pressure upon the animal), as well as in the point of union of the musculi graciles (from slipping). In calves which are roughly pulled about by the tail, extensive hemorrhages, according to Ellinger, may occur in the pelvic connective tissue as far up as the adipose capsule of the kidneys.

The author has already called attention to the frequency of the fibrillar muscle ruptures in fat hogs. Since all ruptures of muscles are accompanied by bleeding, these ruptures cause so-called multiple hemorrhages in the musculature of fattened hogs.

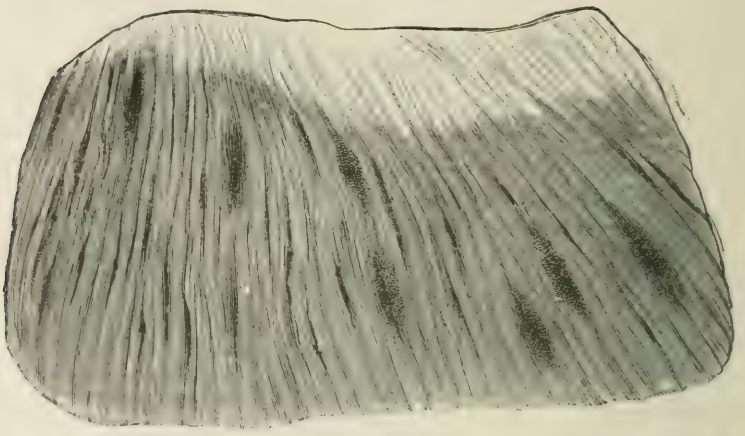
Fibrillar muscle ruptures and the associated multiple hemorrhages are observed chiefly in the muscular portion of the diaphragm and in the muscles of the abdomen and loins, as well as in certain muscles of the anterior and posterior extremities, and more rarely in the whole musculature, in a more or less uniform manner. The number of hogs which show hemorrhages only in the diaphragm is a large one. Without including isolated cases of hemorrhages, it amounts to about 8 per cent. of all slaughtered animals.

The animals in question show no pathological symptoms during life and the internal organs do not differ in their condition from those of healthy animals. My investigations indicate the deposition of fat in the contractile portion of the muscle fibers in the form of granules, such as occur in fatty metamorphosis, as the cause of fibrillar muscle ruptures. As a rule, the muscular portion of the diaphragm is most affected. In consequence of the deposition of fat, the muscles become softer and more easily torn. Associated with this condition is a defective use of the musculature in fattened

hogs which favors their easy rupture. In the hemorrhagic areas, the red blood corpuscles are in general well preserved. This indicates that the immediate cause, the occasion of fibrillar muscle ruptures in our cases, is to be sought in the excessive muscular work which was required of the animal shortly before slaughter. For fat hogs which in the last months of the fattening process get upon their feet only for the purpose of moving to a full trough, the transportation to the slaughterhouse is the first heavy muscular work and the longer or forced driving of the hogs is sufficient to produce a rupture of the weakened muscular fibers.

This assumed mode of origin of fibrillar muscle ruptures in fattened hogs stands in complete harmony with the series of events

FIG. 92.



Diaphragm of a hog with fibrillar muscle ruptures and consecutive multiple hemorrhages.

which are observed in connection with the attenuation of individual muscles and muscle groups. For, even in case of easy transportation, a certain degree of dyspnea appears in fattened animals whereby an excessive strain is put upon the diaphragm and abdominal muscles which function in inspiration, while the muscles which are used in locomotion are only moderately exercised. The more frequent occurrence of affections of individual muscles of the extremities by the alterations in question is partly explained by the more extensive deposition of fat granules in the fibrillæ and partly by their especial significance for locomotion.

Ellinger observed the following sequence in muscles affected with fibrillar ruptures: (1) Diaphragm, (2) obturator internus, (3)

lumbar muscles, and (4) gracilis and neighboring muscles. The other muscles (of the trunk, anterior extremities and neck) were also rarely affected in the cases observed by Ellinger, viz.: in only 3 to 5 per cent. of all hogs which were affected by fibrillar muscle ruptures.

The influence of defective exercise of hogs upon the occurrence of fibrillar muscle ruptures is shown by the fact that in breeding animals, boars as well as breeding sows, which enjoy a natural mode of life and especially a freer movement than animals which are intended for fattening, muscle hemorrhages are not observed. At least the author has never observed them in boars and breeding sows. The fatty cloudiness of the striated muscle fibers may be demonstrated, on the other hand, in many cases of breeding sows which are fattened late in life.

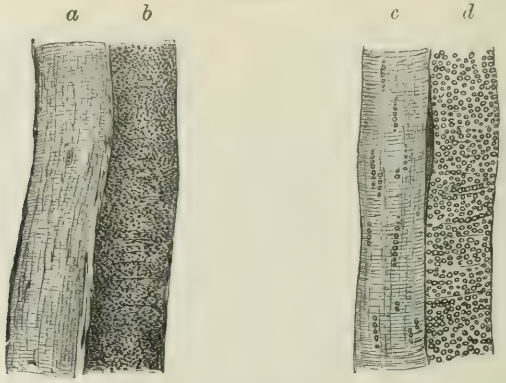
Judgment of fibrillar muscle ruptures.—Multiple hemorrhages caused by fibrillar muscle ruptures lend the affected muscular parts quite an abnormal appearance. The muscles appear to be spotted with black. This is especially conspicuous after boiling and roasting pieces of the meat. Such meat, therefore, in spite of its perfect harmlessness, can not be considered as a marketable food material. In slight cases in which we have to deal merely with alterations of the diaphragm or other favorite locations of hemorrhages caused by fibrillar muscle ruptures, the remainder of the meat may be allowed upon the market without restriction after the removal of the affected part. In addition to the above described hemorrhages, due to fibrillar muscle ruptures, there may also appear, in the musculature of food animals, hemorrhages which are due to toxic and bacterial diseases (phosphorus poisoning, anthrax, black leg, morbus maculosus and septicemia). In these cases there are, in addition to other characteristic alterations, hemorrhages in the internal organs.

Degenerations.—Cloudy swelling and fatty metamorphosis of the musculature are less frequent than similar alterations in the parenchyma of the internal organs, since they occur only in cases of serious toxic and infectious diseases of long standing.* Besides these two conditions of degeneration, however, one observes in the musculature hyaline or wax-like degeneration (Figs. 94 and 96). This alteration, according to the excellent investigations of Zschokke, occurs in domesticated animals more frequently than has previously

* For this reason, even in serious infectious diseases, alterations of the musculature may be wanting if the affected animals are seasonably slaughtered.

been assumed. As was first shown by Fröhner, it is a symptom of hemoglobinuria in the horse. Moreover, Zschokke observed hyaline degeneration of the musculature in parturient paresis and morbus maculosus. According to Zschokke, the muscles do not necessarily show any conspicuous, gross anatomical changes in hyaline degeneration; merely the affected fibers are somewhat thickened. The sarcolemma is preserved, but the protoplasm shows extensive alterations. The striation becomes less conspicuous, the striæ are more widely separated from one another and strongly arched. Finally, the transverse longitudinal striation disappears entirely. The protoplasm then appears to have ruptured in the form of meshes, or homogeneous, glistening, quadrate and roundish masses are formed which

FIG. 93.



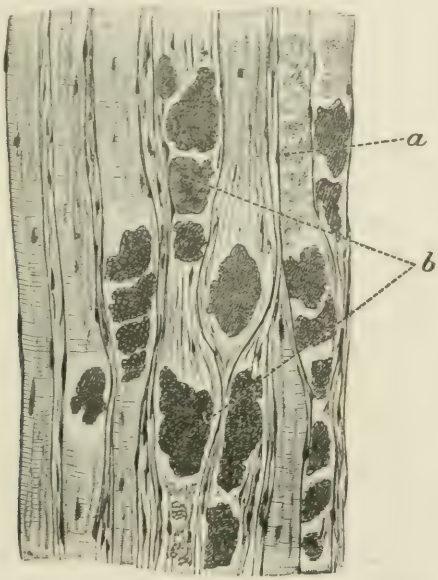
Cloudy swelling and fatty degeneration of the musculature. *a*, normal muscle fiber; *b*, cloudy swelling; *c*, slight, and *d*, extensive fatty degeneration.

occupy the breadth of the muscle fiber. The muscle fiber is thereby interrupted in its continuity and hiatuses appear between the masses. Furthermore, Zschokke demonstrated that the masses possess a greater affinity for stains, especially hematoxylin. Macroscopically, musculature affected with hyaline degeneration does not show a striking discoloration until more than one-fifth of the fibers are diseased. Then the affected muscles appear pale, like the muscles of fish. Their cut surface soon becomes brick-red on exposure to the air, probably in consequence of the increased power of oxidation of the methemoglobin (Zschokke).

A considerable hyaline muscle degeneration, with a fish-like appearance of the musculature, may be observed in cattle as well as in the horse. Thus the Münchener Jahresberichte report several

cases of pronounced hyaline degeneration in cattle and young calves. Furthermore, Hüttner described a case in a steer in which the whole musculature was altered, and, finally, Repiquet described two cases in calves. Repiquet calls attention to the fact that in the musculature of "white" or "boiled" calves the fibrillæ are much more conspicuous than normally, are swollen, opaque, and tinged with yellow or gray. Repiquet compared the cut surface with rotten wood. The alteration, in both cases investigated by Repiquet, was shown in all parts of the muscles of the trunk and affected from one-tenth to two-fifths of the total musculature.

Fig. 94.



Hyaline degeneration of the musculature in the horse in case of hemoglobinuria (after Zschokke). *a*, hyaline fragments; *b*, cleavage and beginning of hyaline disintegration, × 100 diameters.

Judgment.—Among the degenerations of the musculature, it is only the hyaline which possesses an independent significance. Meat altered by hyaline degeneration, on account of its abnormal appearance and poor keeping quality (Repiquet), is undoubtedly a spoiled (inferior) food material. According to Hüttner, beef affected by hyaline degeneration roasts and boils like veal and, according to the statements of consumers, is not of good flavor. Hüttner therefore favors the admission of the meat to the market under declaration.

This procedure, however, is justified only when during the inspection of the slaughtered animals alterations other than hyaline muscle degeneration are not found and when the latter must be considered as an independent alteration incident to the death agony.

Hyaline muscle degeneration in the hog.—A partial hyaline degeneration of the musculature is frequently seen in hogs. Duncker first called attention to this fact. He considered the alteration as originally due to infection by the ray fungus. The assumption of Duncker, however, immediately met with vigorous opposition. Especially, Johne insists that the depositions in the musculature described by Duncker can not be identical with *Actinomyces bovis*, for the reason that they never exhibit the well-known, club-shaped end swellings of the radial hyphæ. Furthermore, in the tissue surrounding the structures described by Duncker, the acute inflammatory reaction which occurs in infection by *Actinomyces bovis*, immediately after penetration of its minute mycelia, is wanting. Zürn went further and expressed a doubt whether the structures in question were of a fungous nature at all.

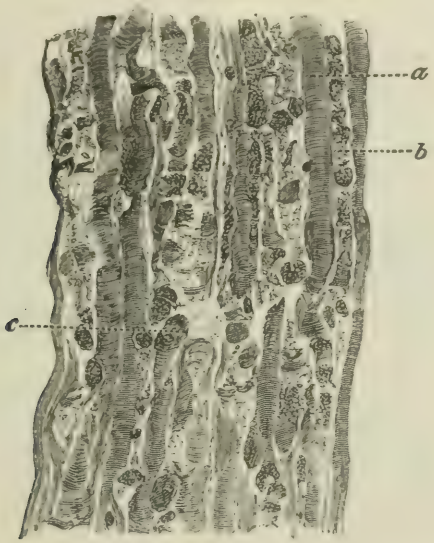
Olt deserves credit for having studied the muscular disease in question and for having demonstrated that the supposed fungous mycelia were nothing more than broken pieces of the specifically altered contractile content of the muscle fibers. They show a stronger affinity for stains than intact sarcoplasm, and in the preparations which Duncker stained with cochineal may have been considered as deposits of foreign substance.

Macroscopically, the specifically degenerated musculature is conspicuous for its pale-red or grayish color, sprinkled with white, its softer consistency and high fluid content. The white sprinkling is in the form of minute points and follows the course of the muscle fibers. The consistency of the degenerated musculature is so reduced that a moderate pressure with the finger is sufficient to penetrate it. The abnormal fluid content in the favorite points for location of the degeneration (muscular part of the diaphragm and abdominal muscles) is so great that one could speak of a regular muscle edema. This edema is of diagnostic value. It is, moreover, noteworthy that the fluid which permeates the altered muscle tissue after cooling of the meat is pressed out and appears in large quantities on the upper surface. This phenomenon is explained by the post mortem rigor of the affected muscle fibers.

In a microscopic examination one observes, according to Olt, whose investigations were confirmed by the simultaneous investi-

gations of Davids and later by myself, in the incipient stages of the loosening of the sarcoplasm or contractile content of the sarcolemma, a gradual disappearance and fusion of the same. Thereby, gaps appear which enlarge to form fissures and spherical cavities and dissolutions of continuity arise in the muscle fibers to such an extent that the contractile content falls into irregular broken pieces of varying size (Fig. 95). All disintegrated fragments are uniformly opaque, but may, however, still exhibit an evident transverse striation. Furthermore, in consequence of contraction of unaffected

FIG. 95.

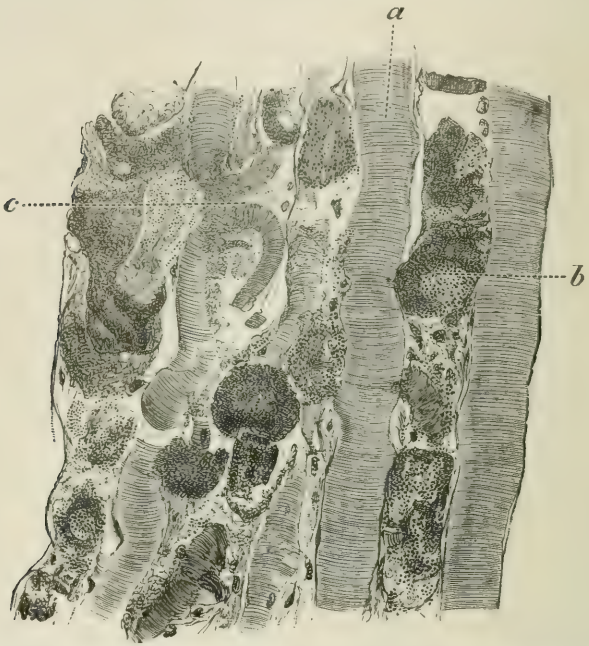


Hyaline muscle degeneration in hogs. *a*, intact fiber; *b*, moniliform arrangement of plasma débris; *c*, point of rupture of a muscle fiber. In other parts of the preparation there are unaffected muscle fibers together with plasma debris of various forms, rupture of the muscle fibers, loss of the sarcolemma and enlargement of the intermuscular tissue. × 35 diameters.

fibers, ruptures of the degenerated fibers may be produced (Fig. 96, *c*) as well as a rounding-off of the protoplasmic débris, so that in affected muscle fibers round or oval protoplasmic balls are observed in a moniliform order (Fig. 95, *b*). The internal perimysium in acute diseases of the muscle fibers is somewhat affected by serous infiltration and exhibits a cellular proliferation. Olt was unable to demonstrate a thickening of the sarcolemma. The sarcolemma is found in the form of a thin membrane over the disintegrated parts. Frequently it is torn and in many affected muscle fibers it is not to be recognized at all.

With regard to the occurrence of the above described process, it is observed most frequently in hogs. It is also found, however, as shown by P. Falk, quite often in the musculature of calves and sheep. Its favorite locations are the muscular parts of the diaphragm, the abdominal muscles and the intercostal muscles. As a rule, the disease is restricted to the muscular part of the diaphragm. Alterations of the whole striated musculature are exceedingly rare.

Fig. 96.



Hyaline muscle degeneration in hogs. A part of Fig. 95 magnified 275 times. *a*, intact muscle fiber; *b*, plasma débris with coccus-like deposits; *c*, point of rupture of muscle fiber. The partial solution of the sarcolemma, the enlargement of the intermuscular tissue, and the chaotic arrangement of the plasma débris are shown more distinctly than in Fig. 95.

Opinions differ concerning the cause of the alteration. Olt believes that he saw streptococci in the altered portions of the muscles. Davids, on the other hand, called attention to the similarity of the structures in question to the sarcous elements into which the muscle fibers disintegrated. Davids considered the whole phenomenon as a simple hyaline degeneration, and, with Erb, regards it as a post mortem process which in the case in question is due to injuries (crushing of the musculature during slaughter).

Judgment.—Previously it was customary to exclude from the market only those hogs in which so extensive an alteration existed that the whole musculature was discolored grayish-red and was strongly infiltrated with water. Even rejected animals, however, were tried out and the rendered fat was utilized as a human food material. In cases where the alterations were restricted to individual muscle parts, as, for example, to the diaphragm or abdominal muscles, only those parts were removed. The frequently-occurring slight alterations were ignored. When extensive alterations were present, it was customary to take the precaution of postponing the decision until after twenty-four hours for the reason that the discoloration and especially the watery character of the musculature was more conspicuous than immediately after slaughter.

This procedure is fully justified, for the reason that, since the investigation of Davids, there is no foundation for the assumption of an injurious character of the meat in question.

Iridescent character of meat.—In highly fattened hogs which neither before slaughter, nor during ordinary inspection after slaughter, exhibited any other alteration, we find with comparative frequency a peculiar alteration of the color and appearance of the longissimus dorsi. This muscle is either entirely or partly discolored grayish, and of a shining appearance upon the cut surface. Under the microscope the muscle fibers appear to be completely intact.

Undoubtedly we have in the anomaly in question a deficiency in the coloring matter of the muscle. The discoloration of the muscle favors this view, as well as the appearance of the iridescent property in boiled and pickled normal meat, in which an artificial destruction of the coloring matter of the muscle has taken place. Legge called attention to the iridescence of boiled and pickled meat.

The gray discoloration and the iridescence of the longissimus dorsi are apparently due to the unhygienic surroundings and nutrition of the hogs.

Judgment.—Iridescent muscles are found in perfectly healthy highly fattened animals and are distinguished merely by the lack of the red color in normal muscles. Since the alteration is sufficiently evident from its conspicuous character and since the buying public, according to past experience, takes no exception to the abnormal appearance of iridescent musculature, we may abstain from placing any trade restrictions upon the meat in question.

Pale condition of musculature.—Faucon found, in a well-nourished four-year-old cow, which before slaughter had been perfectly healthy, that the musculature was pale and of a white color as in milk-fed calves. The white beef differed from veal only in its dryer condition and stronger development of the muscle fibers.

A similar case was observed by Baillet in a beef animal in 1878. Moreover, Villain described a similar case in sheep.

Tallow-like alteration ("steatosis") of the musculature.—Castellant found in a beef animal nearly one-third of the musculature transformed into a tissue resembling adipose tissue.

Inflammations.—Parenchymatous myositis associated with hemorrhage is found in cases of muscular rheumatism. In calves an interstitial myositis occurs which is probably associated with primary degenerative processes of the muscle fibers. This alteration has been called "chicken-meat formation" for the reason that the musculature shows a grayish-white color resembling that of chicken meat.

Stoss described a case of this sort in which the whole musculature of a young beef animal possessed a pale yellowish-red ground color and exhibited yellowish or yellowish-green spots at intervals of about 1 cm. All of the lymphatic glands were enlarged. By a microscopic examination Stoss found an extensive proliferation of the intramuscular tissue and an atrophy of the muscle fibers, which was especially pronounced in the yellowish-green areas.

Bayersdörfer observed a similar case in a bull. The whole musculature exhibited a white color and at the same time a tough consistency.

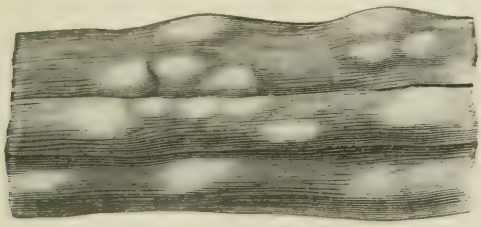
Judgment.—Meat which exhibits the phenomenon of interstitial myositis must be considered as a spoiled (inferior) food material and as such must be excluded from free traffic.

Tumors.—Primary tumors in the musculature are rare. Secondarily, however, sarcomata and also carcinomata may occur in the musculature. Moreover, in the musculature of cattle we may observe a peculiar, thus far insufficiently investigated, tumor formation.

In all, the author has seen four such cases of muscle tumors in cattle. In these cases the whole musculature, but in the most pronounced manner the muscles of the shoulder, sides of the chest and tail, were filled with innumerable granules and tubercles (Fig.

97). All transition stages were observed between structures of the size of a lentil and those as large as a walnut. On the periphery of the larger tubercles smaller tubercles were frequently observed. The color of the neomorphic tissue was grayish-white and its consistency was firm, as in fibromata. The cut surface was dry, uniformly gray, and showed punctate yellow-colored cavities in the center. The larger the tubercles the more numerous were the punctate cloudy areas. All organs, except the musculature, were sound. According to their histological structure, the tumors were to be considered as fibro-sarcomata. Apparently, however, these were cases of neomorphic formation due to infection.

Fig. 97.



Beef tail with fibrosarcoma-like neomorphs.

In all cases observed by the author, the meat, on account of the general distribution of neomorphic formations, had to be excluded from consumption as highly unfit for food.

Infectious Granulations.—Among the infectious granulations in the musculature, we may mention only those which are caused by the tubercle bacillus, actinomyces and botryomyces.

Muscular tuberculosis is of very rare occurrence in food animals, if we disregard the otherwise quite rare cases in which the tuberculous process extends secondarily to the surrounding interfibrillar tissue from the bone or a lymph gland lying in the musculature.

Hertwig described a case of embolic primary tuberculosis of the musculature in a beef animal. During the examination of a four-year-old steer, a pronounced tuberculous alteration of the mesenteric glands was demonstrated. The intestine itself was not affected. In the parenchyma of the lungs, liver and kidneys, embolic masses of the size of walnuts were found. The inguinal and prescapular glands were enlarged to three or five times their normal size and contained caseous masses of varying size. Further-

more, in the subcutaneous connective tissue and skin muscles, and, sparingly, in the deeper lying musculature, especially on the inferior portions of the thorax, on the shoulders, as well as on the interior surfaces of the thighs, flat plaques and moniliform strands were to be observed, which consisted of larger and smaller tubercles and followed the direction of the connective tissue and muscle fibers. The tuberculous nature of these structures was demonstrated by a microscopic examination and by inoculation.

Similar cases were subsequently reported by Godbille, Hüttner, Ströse, Kézévitsch, Mychkine and others.

In cases of the extension of tuberculosis from bones and lymph glands to the neighboring musculature (secondary muscular tuberculosis) grayish-yellow masses are formed, varying in size from a walnut to that of a child's head by a typical formation in the intramuscular tissue with atrophy of the muscular fibrillæ.

Actinomycosis and botryomycosis of the musculature are characterized by an interstitial myositis which develops in the form of masses in the neighborhood of the colonies of actinomyces and botryomyces, or appears in a diffuse condition and later affects larger portions of the musculature as in actinomycotic wooden tongue.

The parasites which occur in the musculature, namely, Miescher's sacs, cysticerci and trichinæ, are discussed in the chapter on "Invasion Diseases."

IX.

ANOMALIES OF THE BLOOD.

Of the anomalous conditions of the blood which occur in food animals, the following are of importance for meat inspection: Deficiency of blood (oligemia, anemia); increase in water content (hydremia); increase in the number of white blood corpuscles (leukemia); and, finally, the appearance of abnormal constituents (hemoglobinemia, cholemia and uremia).

Fluctuations in the amount of blood and its composition possess little sanitary interest of themselves. They only become important through certain phenomena which they may produce in the solid tissues. The alterations of the blood mentioned above are, therefore, unimportant so long as they remain without recognizable influence upon the whole organism or upon the meat.

1.—Deficiency of Blood (Oligemia, Anemia).

Nature and Origin.—By the term deficiency of blood we understand a decrease in the normal quantity of blood. This may be due to various circumstances. Attention has already been called to the fact (p. 131) that an excessively fat condition, especially in hogs, is usually accompanied with a striking diminution in the quantity of blood. This sort of oligemia, which is in part relative, may be characterized as physiological. Pathological deficiency of blood, however, arises when the equilibrium between the income and outgo of the body is disturbed, thus:

By defective nutrition or disturbances of assimilation; or by unusual loss of substance (frequent hemorrhages and parasites).

These forms of anemia are included in the term symptomatic anemia, in contrast with essential or progressive pernicious anemia, which may develop from an unknown cause.

The cases of pathological deficiency of blood which are observed among food animals are, with few exceptions, of a symptomatic nature. The primary affection consists, as a rule, in the invasion of

parasites (stomach, intestinal, liver and lung worms), which cause a diminution in the quantity of the blood, either directly, through removal of nutritive materials, or indirectly, through injury to the important vegetative organs (production of hemorrhages or inflammation). Moreover, anemia may occur as a consequence of non-parasitic organic diseases, such as chronic gastric and intestinal catarrh and chronic infectious diseases, like tuberculosis.

Autopsies in Symptomatic Anemia.—The alterations which are caused by symptomatic anemia vary according to the degree of the latter. Mild cases influence the general condition only slightly. In severe cases, on the other hand, emaciation is a constant phenomenon. Between these degrees, all intermediate stages exist.

The blood is characterized in all cases by its diminished quantity and weak staining power. In contrast with pernicious anemia, it is worthy of mention that even in the severest cases of symptomatic deficiency of blood, the parenchyma and skeletal musculature is, as a rule, intact.

Schaper found a considerable diminution in the number of red blood corpuscles and in the content of hemoglobin, in cases of anemia resulting from distomatosis. The blood of healthy sheep contains from 11,000,000 to 12,000,000 red blood corpuscles per cm.; in anemic animals Schaper found only 6,000,000 to 10,000,000.

Judgment of Symptomatic Anemia.—The meat of animals which are affected with symptomatic anemia is not injurious to health if the primary affection which causes the deficiency of blood has not occasioned a general disease. This may be the case in certain forms of tuberculosis. In ordinary cases of symptomatic anemia in consequence of infestation by worms, the above statement does not hold true. In such cases the meat may become highly unfit for food if the deficiency of blood is accompanied with emaciation. If the condition of nutrition of the animals is still comparatively good and if the animals are to be characterized as poor and not as emaciated (compare p. 243), there is no good reason for restricting the free sale of the meat.

Essential (*progressive pernicious*) *anemia* differs fundamentally from symptomatic deficiency of blood. During life an intermittent fever is observed. Furthermore, the disease usually results in death. The red blood corpuscles exhibit a marked variation from the normal condition (pœcilocytosis). The parenchyma, as well as

the skeletal musculature, becomes cloudy and undergoes fatty metamorphosis. Finally, petechiæ are found in the serous membranes or even in the organs. Although this disease possesses all the symptoms of an acute general affection, it is impossible to discover any cause whatever by post mortem examination. It has rightfully been suspected, on account of the great similarity of post mortem findings with those which appear in certain toxic and infectious diseases, that the cause of pernicious anemia is some virus with toxic action.

Silva asserts that in two fatal cases of pernicious anemia in man he isolated *Staphylococcus pyogenes* from the blood of the heart, and he entertains no doubt that this micro-organism may be the cause of progressive pernicious anemia, for the products of the staphylococcus possessed a hemolytic power, and this fact may serve to explain correctly the symptoms which appear in pernicious anemia: perhaps we have here to deal with a micro-organism of attenuated virulence.

Judgment.—Further investigation is required to determine whether the meat of animals affected with pernicious anemia possesses harmful properties. It should be remembered in this connection that pernicious anemia is also one of the diseases of man. If the condition described by Silva is found to be of regular occurrence, the meat must be considered injurious to health. At any rate, the meat in question must be characterized as highly unfit for food and must be absolutely excluded from the market on account of the substantial alterations which are seen, not only in the entrails, but also in the skeletal muscles. The harm which may be caused to the public from this disease is exceedingly slight, since thus far the disease has been observed with certainty only in horses, and even here with comparative infrequency.

2.—Hydremia.

Nature and Occurrence.—Hydremia, as a rule, is the last result of acute anemia. It consists in a diminution in the blood of the solid constituents and in an increase in its water content. The visible symptoms of hydremia, aside from the marked emaciation, consist in accumulations of fluid in the subcutis, in the intermuscular connective tissue, and in the body cavities (hydremic cachexia). The predisposition of different species of food animals to hydremia varies. The sheep is the most susceptible (especially in extensive

distomatosis and serious invasions of *Strongylus contortus*); young cattle are less so, and older cattle and hogs are rarely affected.

Autopsy.—The shed blood is thin (like meat serum) and reddens the hands only slightly. During exenteration, clear, colorless and odorless fluids pour out from the abdominal and thoracic cavities. The carcass does not stiffen, the connective tissue in the skin and between the muscles shows no trace of fat, but rather a more or less extensive collection of the fluids already described. The meat is watery, the carcass literally drips with fluid, and at the same time the muscles are colored grayish-red in the place of the customary bright red coloration. Furthermore, the muscles are flabby and soft.

Judgment.—The meat of animals affected with hydremic cachexia is to be excluded from the market as highly unfit for food on account of its great deterioration in quality.

The so-called cellular dropsy of sugar factory oxen.—Among oxen used for draft animals about sugar factories a hydremia is observed to which Pütz has given the name "cellular dropsy." The disease is observed where excessive feeding with the watery diffusion products of beet sugar is practiced. Milch cows are seldom affected. In these animals the excretion of water seems to take place through the udder. In affected oxen large edematous swellings appear on the lower surface of the abdomen and on the extremities to such an extent that the animals are finally unable to get up ("water men").

Autopsy.—After slaughter, edematous infiltration of the subcutaneous and intermuscular connective tissue is observed, together with dropsical accumulations in the body cavities. It is a striking fact that even in the more acute cases of cellular dropsy the musculature retains its normal color and is permeated with white adipose tissue which sets readily. This disease is thus distinguished from hydremic cachexia.

Judgment.—A very different decision is to be rendered on cellular dropsy than on hydremic cachexia, for in the first-named disease the characteristic alterations of the musculature are wanting, while in hydremic cachexia they are always present. Furthermore, the quality of the meat in cases of cellular dropsy improves after slaughter, in consequence of evaporation and loss of water. Nevertheless, the meat is of inferior quality as a food material for the

reason that its content of albumen is diminished and its keeping qualities are not so good as in healthy animals. In the most acute cases of the disease, in which loss of water after death fails to take place, the same procedure is to be adopted with regard to the meat as in the case of hydremic cachexia. With regard to a judgment on cellular dropsy, it should be further observed that a superficial examination is not sufficient to determine the amount of water in the connective tissue between the muscles. For determining this point, it is necessary to make deep incisions into the musculature or to cut up the animal according to commercial methods. At the central abattoir in Berlin, the animal body is allowed to hang in the abattoir for twenty-four hours, in order that the final decision may be based upon the character of the meat at the end of that period. In mild cases the meat drys out within this time and resembles normal meat in its appearance, while in acute cases of the disease the meat remains unsightly and oleaginous upon its surface. The post-mortem alterations permit meat inspectors to form a more reliable opinion than could be reached immediately after death.

3.—Leukemia.

Nature.—Naturally, by the term leukemia is understood an anomalous condition of the blood, in which the most important symptom is a considerable increase in the number of the white blood corpuscles. In healthy animals the ratio of white to red blood corpuscles is approximately 1 to 350 ; in the blood of leukemic animals the ratio is much closer, viz., 1 to 50, 1 to 20, or even 1 to 1.

Autopsy.—Corresponding to the great increase in the number of white blood corpuscles, we have in advanced cases of leukemia a striking pale-red color of the blood which is apparent to the naked eye. The blood may even become purulent (Virchow). Wolff in Cleve described a case in a calf in which the blood serum resembled milk. In the heart and large vascular trunks a clay-colored coagulum with purulent accumulations is found in the place of the buff coat of fibrinous deposits. Peculiar alterations of the solid tissues accompany the anomalous condition of the blood. The spleen is considerably enlarged and its follicles are swollen. The color of the surface of the spleen is paler than normal, and upon cross section it is bluish-red or raspberry-red. The consistency of the organ is firm. Koch described a case of leukemia in a cow in which

the spleen was 105 cm. long, 39 cm. wide and 12 cm. thick. The weight of this spleen was 18.05 kg. On cross section the organ showed a bright, reddish-brown color, and follicles of the size of peas. In a case which was observed by Reggianti and Forreggiani in a hog, the spleen was 85 cm. long, 15 cm. wide, 9 cm. thick, weighed 3 kg., and was as hard as a board. The capsule showed a considerable thickening and the cross section had a granitic appearance. In the myelogenous form of leukemia the red bone marrow is hyperplastic and lighter colored than normal. Finally, in the lymphatic form some or all of the lymph glands of the body are considerably swollen and softer than normal ("almost fluctuating"). The iliac, lumbar, prescapular and axillary glands are most affected by the disease. They may reach the size of a man's head; while the other groups of lymphatic glands exhibit swelling only to about the size of a potato, or a clenched fist.

The alterations in the spleen, bone marrow and lymphatic glands may exist independently or may occur one after another. Furthermore, white tubercles (leukemic tumors) and white spots (leukemic infiltrates) may appear in the liver, lungs, kidneys, and upon the serous mucous membranes. Hemorrhages may also be present in the spleen, mucous membranes, and in the serous membranes.

The musculature is of a lighter color than normal and occasionally it is permeated with numerous ecchymoses.

According to Caporini, leukemia occurs also in fowls and is especially characterized by alterations in the liver. The liver is yellowish-white, much enlarged (weighing 200 to 300 g.), and resembles in size and color the fat liver of geese. The structure of the liver tissue becomes partly obliterated, in consequence of the filling of the interacinous tissue with leucocytes.

JUDGMENT.—The sanitary judgment of leukemia is closely connected with the question of its origin. Its origin, however, is still quite unknown. There is a tendency to consider leukemia as an infectious disease, but without a convincing proof of this belief.*

Since leukemia also occurs in man, it may be desirable, until further results are obtained from the investigation of the etiology of this disease, to exercise caution in rendering judgment, and to

* Pawlowsky maintains that he has succeeded in demonstrating bacilli 3 to 4 μ long, in the blood of three leukemic patients. He considers these bacilli to be characterized by the glistening oval spores in the cell body. This announcement has not been further corroborated.

exclude even those cases in which alterations of the intermuscular lymphatic glands and of the bone marrow are not observed. The last mentioned alterations render meat, under all conditions, highly unfit for food.

Otherwise, leukemia does not assume any great importance in meat inspection on account of its rare occurrence among food animals.

Pseudo-leukemia.—In a discussion of the diseases of the lymphatic glands, mention has already been made of the difference between leukemia and the disease described by Cohnheim as pseudo-leukemia. Pseudo-leukemia occurs more frequently in food animals than true leukemia, and is quite often observed in cattle and hogs. It may occur with the same alterations of the spleen, bone marrow and lymphatic glands as are associated with leukemia; the difference consists merely in the fact that in pseudo-leukemia a disturbance of the numeric ratio between the white and red blood corpuscles does not occur.

Judgment.—According to the investigation of Askanacy and Wätzold, which were corroborated by Brentano and Tangl, certain cases of pseudo-leukemia appeared to be of a tuberculous nature. The demonstration of their tuberculous nature, however, can not be made histologically or bacteriologically, but only by inoculation with affected tissue. Roux and Lannois, as well as Fischer, have shown that occasionally *Staphylococcus pyogenes aureus* may produce a general disease of the lymphatic glands resembling pseudo-leukemia. Klein has found the same to be true for *Streptococcus pyogenes*. In a case of lymphatic leukemia observed by the author, in a horse, a bacteriological investigation showed the presence of *Streptococcus* in the enormously-enlarged lymphatic gland. An investigation of several cases in cattle, however, gave negative results.

A certain proportion of the cases of pseudo-leukemia must, therefore, be judged like tuberculosis; others like pyemia; and still others like simple tumors. The sanitary procedure, however, in pseudo-leukemia is a simple matter, since, even in cases in which only simple tumor formation occurs, the meat becomes highly unfit for food on account of the extensive affection of the intermuscular lymph glands, and it must therefore be absolutely excluded from the market.

4.—Hemoglobinemia.

Nature and Origin.—By hemoglobinemia we understand an accumulation of red blood coloring matter, hemoglobin, in the blood serum. This phenomenon occurs whenever a considerable number of red blood corpuscles are constantly disintegrating; the excretion of the hemoglobin with the urine (hemoglobinuria) takes place when more than one-sixtieth of the total quantity of hemoglobin becomes dissolved (Ponfick).

Hemoglobinemia or hemoglobinuria are merely symptoms. The primary affection is the destruction of the red blood corpuscles, which may be due to very different causes. Red blood corpuscles may become disintegrated and dissolved as a result of colds in certain individuals (rheumatic hemoglobinuria); or by burns on the skin, or by certain poisons (for example, chloride of potash, pyrogallic acid); or, finally, by parasites, as in Texas fever and related diseases of cattle and sheep.

The judgment of hemoglobinemia must therefore vary according to the etiology.

Among native domesticated animals there are two common diseases in which hemoglobinemia is a regular symptom, viz.: Black ischuria of the horse and so-called hematuria of cattle.

Black Ischuria of the Horse.

Nature.—Opinions differ concerning the nature of this disease. It has been considered a nephritis (Hering); auto-intoxication (Bollinger); as an effect of increased metabolism in the musculature (Siedamgrotzky and Hofmeister); and finally, as a rheumatic myositis with dissolution of the coloring material of the muscles (Fröhner). The external conditions under which the disease appears (quite likely in unaccustomed rest in stalls), make it probable that so-called black ischuria is auto-intoxication due to the products of metabolism. Moreover, it has been shown that the disease disappears in consequence of exercise and colds. Concerning the nature of the toxic products of metabolism, we have nothing but suppositions.

Autopsy.—Upon post mortem examination we find a shellac-colored noncoagulating or poorly coagulating blood; a white, pale color and an edematous infiltration of the musculature of the hind quarters. On microscopic investigation there appear, as first stated

by Fröhner, and later corroborated by Zschokke, a granular cloudiness, fragmentation, loss of cross-striation, and, finally, a marked hyaline degeneration of the fibers of affected muscles (p. 357).

JUDGMENT.—The Regierung president at Arnsberg, on account of an outbreak of meat poisoning at Altena in which a number of persons were affected and some workmen died as a result of eating the meat of a horse slaughtered for sanitary reasons, called attention to the dangers which may be associated, under certain conditions, with the consumption of such meat. In the decree it was assumed that the horse in question was suffering from hemoglobinemia and it was therefore ordered that in future the meat of horses slaughtered on account of this disease should be absolutely excluded from consumption by man.

It was further stated in the decree, however, that if the horse in question had recovered, but still exhibited a partial paralysis in a mild form, and if a question had arisen regarding the slaughter of the animal on account of its uselessness or loss of value, that the danger of the transmission of the original disease was no longer present. Under such conditions, therefore, the use of the meat may be permitted, in case it is not prohibited for other reasons. With regard to the wording of this decree, it is to be noted that according to our knowledge of the nature of hemoglobinemia in horses, it is improbable that this disease, in and of itself, can render the meat injurious to health. Harmful properties may, however, appear in the meat, if secondary septic processes have developed in consequence of decubitus.

For hematuria of cattle, see under "Texas Fever," p. 533.

5.—Cholemia (Icterus).

NATURE.—In cholemia the constituents of the bile circulate in the blood. Cholemia appears clinically and in the carcass as a yellow coloration of the solid tissues (deposition of bilirubin); consequently the disease is commonly called jaundice (icterus) from its chief symptom.

The cause of cholemia is a partial or total obstruction of the ductus choledochus (in consequence of duodenitis, bile concretions, and parasites—especially wandering nematodes). In this manner hepatogenous, or retention, icterus arises.

The second form of icterus is known as hematogenous or anhepatogenous, and is caused by an excessive disintegration of red

blood corpuscles. Hematogenous icterus accompanies certain intoxications; for example, poisoning from phosphorus, as well as certain infectious diseases, especially pneumonia of horses and swine plague. Anhepatogenous icterus may also arise in connection with extensive hemorrhages (hematoidin being identical with bilirubin). Hematogenous icterus is, therefore, a concomitant phenomenon and does not possess the independent significance which attaches to hepatogenous icterus.

Autopsy.—In severe cases of cholemia, all the tissues are colored yellow or yellowish-green. Upon microscopic examination deposits of bilirubin crystals are found in the yellow colored tissues; these crystals are especially abundant in the tissues of the liver and kidneys. Normal conditions prevail with the exception of the yellow color. Moreover, the complete retention of the bile may lead to considerable disturbance of nutrition (emaciation); the latter condition is associated with a marked yellow coloration.*

Judgment.—Cholemia does not render the meat dangerous to health, but merely lessens its value. The deterioration in quality results from the abnormal coloration of the tissues. The utilization of jaundiced meat for human food depends, otherwise, upon the intensity of the yellow color. In moderate cases the meat is usually permitted to be sold without restriction. Strongly colored meat, however, is sold as inferior food material, under declaration; while meat of an intensive greenish-yellow coloration is absolutely excluded from the market.

Hertwig called attention to the fact that a decision concerning icteric animals should never be made until the carcass has entirely cooled off, for it happens quite often that animals, especially hogs, which exhibit a striking yellow coloration immediately after slaughter, lose this color after becoming cold. This remarkable post mortem phenomenon is to be explained by the presence of a reducing power in the living tissues (see page 198). Incidentally it should be noted that jaundice can only be recognized with certainty in daylight or by electric light, and that it escapes the notice of the observer by gas light.

In *lupinosis*, which must be considered as an intoxication, hepatogenous icterus is one of the most prominent symptoms. Besides

*With reference to the differentiation of pathological jaundice from physiological yellow coloration of the adipose tissue in certain methods of fattening, compare p. 245.

this, alterations of the parenchyma regularly occur (cloudy swelling and fatty metamorphosis of the liver, kidneys, myocardium, and, in severe cases, of the musculature).

Judgment on lupinosis should be the same as for icterus. The admission of the meat of animals affected with this disease to free or restricted sale depends upon the seriousness or intensity of the disease.

6.—Uremia.

Origin.—The accumulation of the constituents of the urine in blood may arise from defective excretion or by the resorption of excreted urine. The first cause is rare in food animals; according to my experience it appears only in the most acute cases of bilateral pyelonephritis of cattle. The second method of origin of uremia is more frequent. A retention of the urine may arise in steers and wethers if the concretions become wedged in the urethra. A favorite location for these obstructions is, as is well known, the S-shaped flexure of the urethra. If the concretion is not removed by operation, rupture of the bladder occurs, with discharge of the urine into the body cavity, or a necrosis of the obstructed part of the urethra with subsequent urinary infiltration of the surrounding tissue.

In cases of urinary infiltration, with gangrene, Guyon and Albarran found *Staphylococcus pyogenes*, a non-liquefying, fluorescent bacillus with pathogenic properties, non-pathogenic cocci, and *Bacillus pyogenes ureæ*, to the last of which the discoverers attributed very offensive properties.

Clinical Symptoms.—Uremic animals, even during life, appear to be very sick and apathetic. In acute cases uremic convulsions are always present. In cases where discharge of the urine into the body cavity or into the subcutis takes place, the expired air has the odor of urine.

Autopsy.—The blood shed at the time of slaughter has a pronounced urinous odor. In the subcutaneous and intermuscular tissues there are everywhere considerable accumulations of a slightly alkaline fluid with urinous odor. More or less numerous and extensive hemorrhages occur in the connective tissues and muscles. If rupture of the bladder has occurred, a quantity of urine is observed in the body cavity and the peritoneum is simultaneously reddened. In urinary infiltration, on the other hand, in the region of the urethra there is an accumulation of urine in the

subcutaneous tissues of the pendant parts of the abdomen and thorax.*

In cases where the urine is retained and a resorption of the undecomposed urine takes place, the carcasses possess the well-known urinous odor. Where, however, the resorption of decomposed urine takes place, the odor is decidedly ammoniacal, in consequence of the decomposition of the urine into ammonia and carbonic acid. This decomposition, however, soon takes place, even in case of resorption of undecomposed urine, so that within a short time after slaughter no difference can be detected in the odor of the meat.

As the animal body cools off, the urinous odor of the meat disappears; the abnormal odor, however, may be made to reappear in its original intensity by warming a piece of meat over a flame or by cooking.

JUDGMENT.—It requires no detailed argument to show that meat which exhibits such a marked fundamental alteration as that of the uremic animals is to be absolutely excluded from the market as highly unfit for human food.

Attention may, however, be called to the fact that urinary discharges which take place immediately before slaughter in consequence of injuries to the urinary passages, do not justify an exclusion of the meat. I have occasionally seen such trifling urinary discharges in the pelvic cavity of heifers which were accidentally injured during coitus immediately before slaughter.

* In uremia of fowls an excretion of uric acid upon the serous membranes, in the air sacs and in the kidneys is observed. Moreover, considerable accumulations of uric acid may take place in the joints and the tissues surrounding them.

X.

POISONING (INTOXICATIONS), EFFECT OF ODORIFIC DRUGS AND SO-CALLED AUTOINTOXICATION.

1.—Poisoning (Intoxications).

Occurrence.—Poisoning of food animals may occur from various causes. Most frequently it is the result of eating poisonous plants along with the fodder (for example, colchicum, cicuta, equisetum, lupines, buckwheat); or of eating other injurious fodder (infested, mouldy fodder, sprouting potatoes, cotton seed, beech nuts, ricinus, mustard cakes, etc.); or by the accidental eating of poisonous substances (lead, arsenic, phosphorus, saltpeter, kainit, salt in large quantities); and, finally, by irrational medication (tartar emetic, mercury, alkalies, veratrin, strychnin, carbolic acid, etc.). With reference to the various poisons, the text-books on toxicology should be consulted, since in this account poisoning will receive only a general discussion.

Detection.—The detection of poisons is possible with certainty only when a trained investigator has opportunity to inspect the poisoned animals, not only after slaughter, but also while alive. The sudden appearance of disease, the serious disturbances in the realm of the central nervous system—accompanied or not by digestive symptoms—and sudden death, furnish the most important criteria for the recognition of poison when considered in connection with anamnestic data.

Autopsy.—The post mortem findings vary. They may be:

1. Completely negative (poisoning from simple nerve poisons, such as morphine, eserin, strychnin).
2. Alterations in the alimentary tract (acid, corrosive poisons).
3. In addition to the two above-named variations, alterations of the blood (hemoglobinemia) and of the solid tissues (icterus) may be present (blood poisons, like chloride of potash, chloroform and phosphorus).

The alterations in cases of poisons in groups 2 and 3 are more pronounced after death, while in group 1 the expert is not in a position to demonstrate by a simple macroscopical examination that poisoning has occurred. Fortunately, however, this impossibility does not carry with it any serious hygienic danger.

JUDGMENT.—Concerning the question of the sanitary judgment of poisoning, the experiments of Fröhner and Knudsen produced especially instructive results.

Fröhner and Knudsen, in their important work, call attention to the fact that for a long time, but incorrectly, the injurious character of the meat of poisoned animals has been considered a veterinary axiom. In this connection it is necessary to distinguish between the possibility of a chemical demonstration of a poison in meat, and the possibility of this poison exercising a harmful effect. For example, a steer weighing 1,000 lbs. would be poisoned with 0.5 gm. strychnin. For a man weighing 100 lbs., on the other hand, the fatal dose is 5 mg. In one kg. of the meat of a steer poisoned with strychnin a man could find, at most, 1 mg. of the poison—a perfectly harmless dose. It should also be known that many wild races kill the game which they use for food by means of poisoned arrows, and, therefore, live exclusively upon the meat of poisoned animals.*

Furthermore, Fröhner and Knudsen call attention to the fact that all experiments which have been reported in the literature on the subject and all observations are against the assumption that the meat of poisoned animals possesses harmful properties. Harms proved this point for nux vomica and tartarus stibiatus; Feser for strychnin and eserin; Spallanzani, Zappa and Sonnenschein for arsenic.†

* Thus, for example, the Akas, a mountain race in the north of Brahmaputra, kill their food game by arrows which, according to an investigation by Waddell, are poisoned with aconitin.

† The experiments and observations cited from the literature on the subject by Fröhner and Knudsen concerning the harmlessness of the meat of poisoned animals may be supplemented by the following: Gautier reported concerning the poisoning of calves with cotton-seed meal cakes. The meat of calves, which was of good appearance, was eaten without harm. Feser made a report concerning experiments with the meat of horses which had been killed with apomorphine (10 gm. in 250 gm. of water injected directly into the veins); the raw meat was eaten by dogs without any ill effect. Likewise a subcutaneous injection of the meat serum, as well as perfectly fresh blood, caused no tympanites or other symptoms of disease in dogs. According to Peschel, a dairyman lost four cows by poisoning with colchicum. The meat of the animals was eaten without producing any ill effects.

Fröhner and Knudsen have recently reported their own experiments with strychnin and eserin. On the basis of these experiments they declare that the meat of animals which have been poisoned with either strychnin or eserin is not harmful.

The following abstract may be given of these experiments :

1. *Strychnin.*—A wether weighing 39 kg. and a ewe weighing 24 kg. were poisoned with 0.05 and 0.03 gm. strychnin, respectively. Death took place after 20 and 19 minutes. Pieces of the muscle (750 and 500 gm.), as well as the livers (400 and 300 gm.), were treated according to the method of Dragendorff. The reaction for strychnin took place in all cases and a physiological experiment with white mice also gave positive results. Three dogs, however, weighing 15, 17 and 18 lbs. respectively, ate 2 lbs. each of the raw meat without suffering any harm. The authors themselves ate ½ lb. of the cooked meat. The meat as well as the broth had an agreeable taste, was not bitter and caused no ill effects.

2. *Eserin.*—A wether weighing 32 kg. received 0.5 gm. eserin sulphate and died after 13 minutes. Eserin could not be demonstrated in the musculature (1,750 gm. were used for the investigation) nor in the liver (500 gm.). On the other hand, an examination of a mixture of the heart, kidneys, lungs and blood (in all, 1,000 gm.) gave a decided eserin reaction. Fröhner and Knudsen ate ½ lb. of the cooked meat without suffering any harm, and the two dogs which were used in the previous experiment each ate 2 lbs. of raw meat without any disturbance of their general condition.

Fröhner and Knudsen call attention to the fact that especial significance is to be ascribed to the negative results which have been obtained with eserin, since eserin exercises a comparatively greater effect upon man and dogs than upon other mammals. Moreover, Fröhner and Knudsen have recently conducted experimental investigations upon poisoning by pilocarpin and veratrin. The plan of the experiments was the same as in previously-mentioned experiments. Sheep and rabbits were poisoned with fatal doses of pilocarpin and veratrin, and the meat of these animals was tested for food, partly by the experimenters and in larger quantities with dogs. The results obtained agree completely with previous results. "The meat of animals poisoned with pilocarpin and veratrin proved to be perfectly harmless as food for man and animals."

In so far, therefore, as septic or pyemic processes do not accompany the intoxications, it may be confidently asserted, on the

basis of experiments made with the four most poisonous alkaloids (strychnin, eserin, pilocarpin and veratrin), that "the medicinal treatment of an animal with any drug whatever does not render the meat dangerous for food."* Even the meat of animals which have died in consequence of an accidental or intentional poisoning possesses no harmful properties, but is simply unfit for food in the sense of Section X of the Pure Food Law of May 14, 1879.

The chemical and physiological investigations of meat have shown that it either contains no poison (in the case of pilocarpin and eserin), or only traces (in the case of strychnin and veratrin). This phenomenon is explained by the above-mentioned fact, that the musculature, as well as the living tissue, decomposes the alkaloids which have been taken up, principally by reduction (see p. 198). Fröhner and Knudsen consider the liver as next in importance to the musculature in the decomposition of alkaloids, while a weaker reducing power attaches to the blood than to the muscles and liver. Excretion of the alkaloids by means of the excretory organs is to be considered as the second factor in the removal of the poison from the organism.

Finally, Fröhner and Knudsen observed that the more easily decomposed glucosids, as, for example, the glucosids of digitalis, behave in a manner similar to that of the alkaloids. The possibility of an injurious effect is much less in the case of mineral poisons than with vegetable poisons, for they exercise a slighter effect. Arsenic, for example, is ten times less poisonous than strychnin; phosphorus, soon after its resorption, is modified into nonpoisonous oxidation products; the metallic salts (lead, copper, mercury, zinc, antimony, silver salts, etc.) are never resorbed except in small quantities, so that in the case of these substances, poisoning by means of the meat is out of the question. The same holds true for poisoning with caustic alkalies and acids.†

According to "Mitteilungen aus der Tierärztlichen Praxis im Königreich Preussen," fifty scabby sheep died from mercuric poisoning in 1880, in Köln. Only very small quantities of quick-

* The correctness of this position has been corroborated, since the publication of the experiments of Fröhmer and Knudsen, by a manifold experience. Thus, on the basis of the experiments in question, Warncke admitted to the market the meat of a cow which, one hour before compulsory slaughter, had received 2 gm. morphine in the form of a subcutaneous injection. The tissue around the point of injection and the entrails were removed. The meat was eaten without any ill effects.

† In cases of poisoning from acid, caustic substances, it should be noted that septic processes may develop if the action of the caustic substances is long continued.

silver could be demonstrated in the mutton. Ludwig made a report to the Society of Physicians in Vienna concerning the distribution of mercury in the different organs of man and animals which had died from corrosive sublimate poisoning. Taking 1,000 as the basal number, 225 parts were found in the kidneys, 87 in the liver, 53 in the large intestine, 38 in the spleen, 6 in the small intestine, 1 in the brain, and only minimal quantities in the muscles and bones. Albrecht reports that the meat of two cows which had drunk a decoction of lead ore and had died as a result, was fed to several dogs and cats without causing any bad effects. A dog belonging to Albrecht received 120 lbs. without the slightest ill effects. According to Ellenberger, the blood and musculature contain very little lead in cases of chronic lead poisoning. The internal organs (spleen, kidneys and liver) contain more, but only 0.01 per cent. Laho and Mosselmann fed a young steer, weighing 185 kg., 50 gm. (daily) of a resinous paint, $\frac{3}{4}$ of which consisted of white lead. The steer died on the sixth day and a chemical investigation disclosed the presence in the kidneys and liver of 40 mg. lead sulphate per kilogram. Traces of lead were demonstrated in the brain, while in the meat not even a trace of the dangerous metal could be detected. The meat was fed to dogs during a period of several weeks and the animals showed not the slightest disturbance in their condition.

Abnormal Condition of Certain Organs.—Fröhner and Knudsen expressly assert that their experiments related only to meat (including the heart, liver and kidneys). The stomach and the intestines of poisoned animals, on the other hand, are always dangerous on account of their poisonous contents.* These facts are to be remembered in cases of emergency slaughter where powerful poisons are administered, not by the mouth, but subcutaneously, since these poisons are excreted through the glands of the stomach and intestines. Naturally, in cases of subcutaneous injection of powerful drugs, the point of injection must also be considered dangerous and must be removed before the meat is admitted to the market. In addition to the stomach and intestines, the udder occupies a special position among the organs of poisoned animals, according to an observation of Schmidt in Crossen.

A family of seven were attacked with acute pains and violent vomiting immediately after eating the udder of a cow which a few

* According to Schultz, a whole family was made ill by eating fieldfares which had eaten meat poisoned with strychnin and intended for foxes. The stomach of these birds, as is well known, is always eaten with the other edible parts.

days before, in the course of the last five days before slaughter, had received 18 gm. of veratrum album, the dose on the last day before slaughter being 4.5 gm. No evidence was obtained of any harmful property in the meat.

According to statements of Lewin, the meat of fowls which have received large doses of strychnin has been shown to be dangerous. As is generally known, fowls are almost immune to strychnin and may therefore take large quantities of the poison. Lewin administered 0.02 gm. of strychnin by way of the mouth to fowls during a period of 14 days. After the fowls had died a dog was fed upon the meat. After the first meal of 125 gm. the animal showed symptoms of disease which developed after further feeding into a regular tetanus, resulting in death. It is stated that an investigation of the internal organs of fowls poisoned with strychnin showed no evidence of the poison, while a considerable quantity was found in the muscle meat. According to Schneider, the meat of geese, fowls and pigeons which had died from fatal doses of strychnin proved to be harmless.

Jantzon fed the internal organs and some of the meat of a cow which had been slaughtered soon after receiving a subcutaneous injection of strychnin, to a number of small dogs (dachshund and terriers), without ill effects, while a hunting dog which was fed the meat from around the point of injection was affected with violent strychnin convulsions.

2.—Effect of Odorific Drugs on the Meat.

In cases of emergency slaughter the meat inspector often has opportunity to inspect animals the meat of which possesses an abnormal odor. Aside from the foul odor which meat assumes when processes with a disagreeable odor have developed in the body (sapremia and septicemia), we may observe in the place of the normal meat odor various other odors which strongly resemble those of certain drugs.

The majority of our aromatic drugs which, contrary to the rules of the veterinary prescription regulations, are administered to diseased food animals, transmit a very specific or somewhat modified odor to the meat, if they have been administered in large quantities and if the period between the administration of the drugs and the slaughtering of the animal has not been too long. To this group of drugs belong ether, camphor, turpentine oil, kerosene, asafetida,

oleum carvi, anise oil, carbolic acid and chlorin preparations. Carbolic acid and chlorin are, strange to say, actively absorbed by the body and retained for a long time, if the drugs are not administered by way of the mouth but inhaled along with the inspired air. Among such, cases have been observed which have been transported in recently disinfected freight cars, or have been placed in freshly-disinfected stalls.

Demonstration of Abnormal Odors.—What was said concerning the more conspicuous appearance of ammonia in the meat of uremic animals when subjected to artificial heating (p. 378), holds true also for other abnormal odors of the meat of slaughtered animals. These odors are more easily detected after warming or cooking the meat.

Judgment.—In all cases in which the abnormal odor is due to the administration of aromatic drugs, the opinion concerning the utilization of meat will be determined as in cases described on p. 245 *ff.*, according to the intensity of the odor. In slight cases the meat can be admitted to the market unhesitatingly, under declaration. In other cases, on the contrary, in which a foul stench is emitted from the meat, such meat is to be considered highly unfit for food and is to be absolutely prohibited from sale.

3.—The So-called Autointoxication.

In the discussion of blood diseases, three affections have already been named, which from an etiological standpoint are to be considered as autointoxications, *i. e.*, as cases of poisoning due to metabolic products of the body. These diseases are cholemia, uremia and the so-called black ischuria. A suitable discussion has been given above to these diseases. In cholemia and uremia we have to do with the retention or resorption of the bile and urine. The conditions are not so simple in black ischuria. We do not know what substances act in a poisonous manner in this case. However, the origin and course of the disease, as already mentioned, make it exceedingly probable that the so-called black ischuria is a form of poisoning due to some metabolic products of the body. Similar conditions are found in parturient paralysis. A special discussion of this disease follows.

Parturient Paralysis.

Ludwig Franck deserves credit for having called attention to the fact that the diseases which occur immediately after parturition and which previously had been designated by the name parturient paralysis, or milk fever, are really of two forms. Franck distinguished a septic and a paralytic parturient fever. The two diseases have nothing in common, except the fact that they occur after parturition. Septic parturient fever is an exquisite septicemia. The paralytic form, on the other hand, is a marked case of poisoning. This distinction is of the greatest significance for meat inspection and we must agree with Friedberger and Fröhner when they propose to characterize the difference between the two diseases by the use of the term "parturient paresis" in the place of the less applicable term of "paralytic parturient fever."

Occurrence, Course and Autopsy.—Parturient paresis occurs most frequently in cattle, less often in goats and hogs. It begins with a short stage of irritation, thereupon a paralysis of the posterior extremities follows, and rapidly extends to the other parts of the body. The paralysis is both motor and sensory. Moreover, the smooth musculature (of the intestines and bladder) is paralyzed. Even in acute cases, however, recovery may take place with astonishing rapidity. Otherwise, death follows in consequence of cerebral paralysis. Gross anatomic lesions are not present. The post mortem finding is negative, as in the case of poisoning. The uterus exhibits no injuries or inflammatory symptoms; it contains only a small quantity of odorless fluid. This condition is in complete harmony with the fact that parturient paralysis is usually associated with cases of easy parturition.

It should be noted that parturient paresis appears from twenty-four hours to three days after birth, and that it is almost exclusively the well-nourished, highly-fed and well-cared-for animals which are attacked by the disease.

Etiology.—Opinions concerning the cause of the above described phenomena vary, like those concerning black ischuria. Franck attempted to explain parturient paresis by cerebral congestion, with subsequent cerebral edema; Harms, by the absorption of air in the blood vessels of the brain (aeremia). The hypothesis of Franck, as Schmidt-Mülheim has asserted, does not harmonize with the disease.

The aeremia of the blood vessels of the brain, however, is an artificial condition which is almost always produced by removal of the cranium. The view entertained by Schmidt-Mülheim, that in this disease we have to do with a substance resembling an alkaloid, which is formed in the body of animals, is best calculated to explain the acute spinal and cerebral symptoms. It is doubtful, however, whether the hypothesis of Schmidt-Mülheim is well-founded, viz., that the toxic substances resembling the poisonous principles in cases of sausage poison, owe their origin to a peculiar decomposition of the lochial fluid in the uterus. According to the results of the method of treatment recommended by Schmidt of Kolding (iodin infusions into the milk cisterns), it is more probable that the hypothetical poisonous principles are formed in the udder.

Although we are not able to explain with certainty the origin of parturient paresis, it may be safely assumed that in this disease, as in black ischuria, we have to do with an intoxication. The poison may be produced by the action of bacteria; it may be a toxin; there is no evidence, however, to justify the assumption of such an origin. The complete integrity of the organs argues against such a method of development. It is more probable that parturient paresis is caused by leucomaines which arise in certain animals in consequence of physiological processes. Such a leucomaine, for example, according to the investigations of Rémy, is developed in a fish (diodon) which lives in the Japanese Sea. The poison appears in the glands when these organs are in a condition of physiological rest.

W. Eber considers parturient paresis, as well as black ischuria, to be a "toxigen disease."* He assumed that toxigen is formed in the reproductive organs of healthy cows, but that in such situations it remains toxigen, or is excreted as such. In diseased animals, on the contrary, he believes that we have to do with a transformation of the toxigen into an active poison in consequence of metabolism.

* The general term "toxigen" or "toxigenous substances," according to W. Eber, should include all those chemical bodies which assume poisonous properties only in consequence of the action of the animal organism. Such a peculiar interconnection between a toxigen and the animal body is observed, for example, in iodic acid, iodid of soda, and iodin with iodid of soda. The intoxications caused by these substances are distinguished by the fact that the beginning of the poisonous symptoms occurs after an incubation period: the poisoned animals do not manifest any symptoms of disease for several hours (six to eight) after intravenous injection of iodid of soda. It is not until after this period that marked symptoms of poisoning occur.

JUDGMENT.—Physicians have repeatedly stated, and the statement has been again recently repeated in England, that the meat of animals affected with parturient paresis must be considered as a dangerous food material. This assumption is not well founded. In the first place, veterinary experience is against it. Up to the present time, no instance of harm in man has been observed from eating the meat of animals which were affected with parturient paresis. If parturient paresis could cause dangerous properties in the meat, this fact could not possibly have remained unknown, in view of the great frequency with which the disease occurs, for the meat of animals affected with parturient paresis, even in countries with a regular meat inspection, is in the majority of cases admitted to the market, chiefly for the reason that gross anatomical alterations are absolutely wanting in cases of the disease in question. This practice is strengthened by the hypothesis of Franck and Harms concerning the origin of the disease.

Friedberger and Fröhner call attention to the fact that complications with septic parturient fever may occur in addition to simple cases of parturient paresis. "Indeed, cases are not rare in which we find the clinical symptoms of parturient paresis and the anatomical symptoms of a septic inflammation of the uterine mucosa." The meat inspector should bear this fact in mind, since meat in process of sepsis is to be judged quite differently from that in cases of parturient paresis. The demonstration of a complication of parturient paresis with septic parturient fever offers, however, no difficulties, since in the latter case the uterus exhibits conspicuous alterations (septic metritis).

Moreover, the meat of animals which have been affected with parturient paresis is to be considered as of inferior value for food, and should therefore be sold only under declaration. The inferior quality of the meat is apparent from the fact that it comes from animals subjected to compulsory slaughter, which is, as a rule, good evidence of imperfect bleeding; this condition is due to the fact that slaughter is postponed until the paralysis is complete.

Finally, attention should be called to the fact that in earlier times the odor of drugs was not observed in the case of any disease so frequently as in parturient paresis. This fact is explained by the method of treating the disease, in which aromatic stimulants (ether, camphor, turpentine oil) played an important part.

XI.

ANIMAL PARASITES (INVASION DISEASES).

The number of animal parasites which have been observed in food animals is unusually large. A sanitary significance, however, attaches only to those parasites which have their seat in organs which serve as food for man. For this reason, the majority of the numerous skin parasites are without significance for meat inspection, since the skin of food animals, with the exception of hogs, is, as a rule, not utilized as human food.

The sanitary significance of different species of animal parasites varies considerably. Only a few species of animal parasites possess great significance; the majority are unimportant. According to their importance in meat inspection, the greater number of animal parasites which are found in the body of food animals may be divided into three groups:

1. Parasites which are not transmissible to man.
2. Parasites which may be transmitted to man by eating meat.
3. Parasites which are not immediately harmful, but which may become so after a preliminary change of host.

As will be readily understood, the greatest interest attaches to those parasites which belong to the second and third groups. These parasites, or rather the parts of food animals which are infested by them, must be excluded from the market. Meat inspection must also take account of the parasites of group 1, since they produce in the organs the characters of inferior food material; and it is, furthermore, the duty of meat inspection to destroy those parasites which, in a larval condition, are injurious only to domesticated animals.

It would transcend the limits of a handbook of meat inspection if we were to go into a detailed description of all the parasites which are here concerned. A detailed description is justified only in the case of those parasites which may offer difficulties in identification. In the case of others, a short statement concerning their form and

size is sufficient for the purpose of meat inspection. With regard to further peculiarities of these parasites, reference should be made to the text-books of parasitology by Zürn, Leuckart, Braun, Railliet and Neumann. The anatomical alterations which are produced in the organs of domesticated animals infested with animal parasites will receive a more detailed consideration.

1.—Parasites Which Are Not Transmissible to Man.

Of the parasites included under this head, the following will receive attention :

1. The hair follicle mite in the skin of hogs.
2. Various endoparasitic dipterous larvæ.
3. Numerous worms which occur in the organs of food animals.

1.—The Hair Follicle Mite of the Hog.

The hair follicle mite (*Demodex phylloides suis*), discovered by Csokor, is parasitic in the skin of the hog. It is from 0.2 to .25 mm. long and produces small swellings of the hair follicles which ordinarily project only slightly beyond the surface of the skin. The swellings show a predilection for the snout, neck, under part of the breast, abdomen and flank, as well as the inner surface of the thigh. They are less conspicuous for their size (from that of a mustard seed to that of a lentil) than for their gray or yellowish color and sharp delimitation from the neighboring tissue. The enlarged hair follicles contain a soft semi-fluid material, consisting of disintegrated epithelial cells and dermal oil, in which the follicle mites may be demonstrated in large numbers. In the case which was investigated by Csokor, and which led to the discovery of the parasite, the swellings of the hair follicles had reached the size of a hazelnut and were partly transformed into ruptured abscesses.

Judgment.—The judgment of organs infested with parasites which are not transmissible to man is very simple ; it will therefore be sufficient to discuss the matter in a general way for group 1 (p. 417).

2.—Dipterous Larvæ.

In cattle, the larva of the ox warble fly (*Œstrus bovis*) is found in various parts of the body. The most striking, and for meat inspection the most important, alterations caused by these larvæ are

in the subcutis, in which they undergo their last development stage. In this position they produce swellings which may attain the size of a walnut. In cutting into the swollen parts, it is observed that the larvæ, which, after attaining complete development, are 28 mm. long and 12-15 mm. wide, are surrounded with pus and lie in a granulating membrane. In the vicinity of these swellings there are more or less extensive collateral swellings. The first larvæ are observed in the subcutis in January. The migration from the subcutis begins in April.

The œstrus larvæ are observed only in cattle at pasture, and most frequently in young animals. In regions in which cattle remain at pasture day and night, as, for instance, in the marshes of Schleswig-Holstein, the parasites are extraordinarily abundant. Thus Ruser reports from the abattoir at Kiel that in that locality from one-fourth to one-third of all the cattle were infested with warble flies.

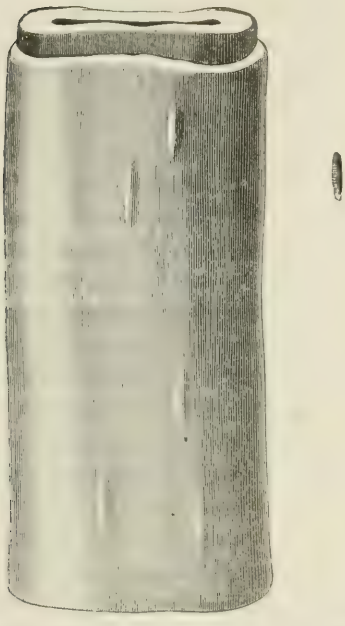
The parasitism of œstrus larvæ causes considerable loss to cattle raisers. In England the injury is estimated at 160,000,000 marks per year. The chief damage lies in the deterioration of the skins. Furthermore, the parasites cause a decrease in the value of the meat, since, when they are present in large numbers, a considerable portion of the subcutis and skin muscles must be removed. Butchers fear especially the edematous infiltration of the subcutis, which in England is characterized as "licked beef," or "butchers' jelly," for the reason that the surface of meat which is changed in this manner possesses a dirty greenish-yellow appearance after from twelve to twenty-four hours.

Development Stages of Œstrus Larvæ.

Formerly the view was held that the development of œstrus larvæ took place exclusively in the subcutis. Careful investigations, which were begun by Hinrichsen and were carried on by several abattoir veterinarians, have shown that this view is incorrect. Hinrichsen, in his earlier work, in connection with the inspection of slaughtered and dead cattle in Husum, found numerous larvæ scattered about in the adipose tissue between the dorsal vertebræ and the dura mater of the spinal cord. The larvæ were 10 to 15 mm. long and 2 to 3 mm. wide, clear and transparent and partly gray-green in the middle. The larvæ lay in a uniformly edematous infiltrated swelling. This finding was corroborated by Horne, Ruser, Goltz and Koorevaar in the abattoirs at Christiania, Kiel, Schwerin and Amsterdam. Goltz, Ruser and Koorevaar found also that the youngest stages of

the larvæ occur as small hyalin structures under the mucous membrane of the esophagus. It was, therefore, assumed, in harmony with Ruser, that the larvæ of the ox warble fly, after hatching from the eggs, penetrate into the mouth cavity and pass thence into the esophagus, where their first development is undergone. During the first months of the year, Ruser found the thoracic portion of the esophagus most thickly permeated with the larvæ and concluded from this fact that the larvæ had left the esophagus, had made their way upward into the mediastinal fat tissues, and had travelled along the blood vessels and nerves partly into the spinal canal and partly directly into their final situation, the subcutis.

FIG. 98.



Beef esophagus with œstrus larvæ. On the right a larva in natural size.

This assumption did not remain uncontradicted. Thus, Neumann held it for certain that the larvæ which he had opportunity to study in the vertebral canal were not those of *Œstrus bovis*. Koorevaar, however, dispelled this doubt, since he was able to rear the ox warble fly from larvæ which he obtained in the spinal canal. Moreover, we owe to Koorevaar a thorough investigation concerning the migration of œstrus larvæ in the body of cattle.

Toward the end of June, Koorevaar found in the wall of the esophagus very small hyalin larvæ, the smallest of which were scarcely 2 mm. long, and the largest 3 to 4 mm. During the succeeding months the larvæ were found throughout the whole extent of the esophagus, from the pharynx to the cardiac end. They were located between the mucous membrane and the muscular layer. In July some of the larvæ penetrated the muscular layer in the cervical portion of the esophagus and took up a position in the connective tissue surrounding it. By the middle of August, when numerous larvæ were present in and outside of the esophagus and in the mediastinum, some specimens 5 mm. long were found in the

subdural fat tissue of the spinal canal. During the autumn months larvæ varying in length from 5 to 13 mm. were still found in the esophagus. The majority of them, however, had already wandered to the spinal canal. From October until January, it was not a rare thing to find as many as forty larvæ in the spinal canal of a single animal. In young cattle as many as fifty-seven larvæ were found, which were distributed throughout the whole length of the spinal canal from the neck to the cauda equina, but most numerously in the lumbar region of the spinal cord. Frequently larvæ of the same size were found in the esophagus and in the subdural fat tissue. By the end of December, Koorevaar observed a dirty yellow, brown, or occasionally hemorrhagic edema in the subcutis, which indicated the arrival of the larvæ at the point of their final development. In the winter months, the simultaneous occurrence of œstrus larvæ in the esophagus, in the subdural fat tissue and in the subcutis, in the same animal, is not rare.

According to Koorevaar, the larvæ of the ox warble flies which are on the wing in July, are distributed as follows:

From July to September, in the esophagus; from September to January, in the spinal canal; from January to May, in the subcutis and skin.

The larvæ of the later appearing flies, on the other hand, are distributed as follows:

From October to December, in the esophagus; from December to April, in the spinal canal; from April to August, in the subcutis.

It appears strange that in cutting up cattle the œstrus larvæ are so seldom met with in their migration through the musculature. Horne asserts that in the months from February to April he observed dirty green larval passages in the musculature on frequent occasions. Furthermore, Ruser reports the finding of warble swellings in the musculature (longissimus dorsi). Although migrating larvæ have never yet been found in the musculature, this fact is to be explained by the rapidity with which œstrus larvæ are able to wander to their resting place. Koorevaar placed eleven larvæ and eight days later fifteen larvæ under the skin of a dog. When the wound was opened one hour after the operation only one larva was still at the point of the operation; the remaining fourteen had disappeared. When the dog was killed, fourteen days later, all of the twenty-six larvæ which had been introduced were found; five in the subcutis, six between the folds of the intestines free in the

body cavity, five in the fat tissue of the spleen and kidneys, three in the psoas muscles, three in the wall of the esophagus, two around the trachea and two in the subdural adipose tissue. The parasites had, in the space of eight to fourteen days, completed these extensive migrations, and yet no traces were to be found either of the larvæ or the passages through which they had made their way.

With reference to the recognition of young larvæ, Ruser has correctly called attention to the diagnostic value of the edema which accompanies the location of the larva (Fig. 98).

The sheep bot fly (*Œstrus ovis*) lives parasitically in the nasal cavity and connected passages of the sheep, and may cause irritation of greater or less severity (catarrh of a simple or acute form). The larvæ, which are at first very small, develop finally to yellowish-brown oval structures from 22 to 28 mm. long.

In the pharynx and stomach of the horse we find the larvæ of *Gastrophilus equi* (19 mm. long); in the duodenum of the horse, *G. nasalis* (15 mm. long); in the alimentary tract of horses and cattle, the larvæ of *G. pecorum* (13 mm. long); and, finally, in the esophagus, stomach and small intestines, or occasionally in the colon of the horse, *G. hæmorrhoidalis* (16 mm. long).

3.—Worms.

Among both groups of flat and round worms the following parasites are not transmissible to man:

(*a*) All tapeworms of food animals, with the single exception of *Tænia echinococcus* of the dog.

(*b*) The larval stages of all tapeworms of food animals, with the exception of *Cysticercus bovis*, *C. cellulosæ* and *Echinococcus polymorphus*.

(*c*) All fluke worms (trematodes).

(*d*) All nematodes (*Ascaris*, *Eustrongylus*, *Filaria*, *Oxyuris*, *Strongylus*, *Trichocephalus* and *Acanthocephali*), with the single exception of *Trichina spiralis*.

In the case of the majority of these parasites, the discussion may be limited to the most important facts.

(a) Tapeworms (Cestodes).

The greatest importance attaches to *Moniezia expansa*, which causes the tapeworm disease of lambs, as well as to *Drepanidotænia lanceolata* and *D. setigera*, which may cause extensive losses in geese,

and finally to *Davainea tetragona*, which causes epizootic outbreaks among young fowls.

Moreover, in the horse we may observe *Anoplocephala perfoliata* (in the small and large intestine, up to the length of 80 mm.); *A. plicata* (in the small intestine, 1 m. in length), and *A. mamillana* (in the jejunum and ileum, 50 mm. in length); in cattle, sheep and goats, *Moniezia expansa* (4 to 5 m.* in length); in cattle and sheep, *M. planissima* (1 to 2 m. in length), *M. alba* (60 to 250 cm. in length), *M. benedeni* (up to the length of 4 m.); in sheep only, *M. neumanni*, as well as *Thysanosoma acrilla* and *T. actinioides*; finally, in the dog, *Taenia coenurus* (in the small intestine up to the length of 40 cm.), *T. marginata* (1.5 to 3 m. in length), *T. serrata* (in the small intestine, 50 to 60 cm. in length), and *Dipylidium caninum* (in the small intestine, 10 to 40 cm. in length).

(b) Larval Stages of Tapeworms.

In sheep and exceptionally in cattle we find the preliminary stage of *Taenia coenurus*, known as *Coenurus cerebralis*. It is located in the brain and spinal cord. The bladder worm is of a roundish or elongated form and of varying size, from a millet seed to that of a hen's egg. On the inner surface of the wall there are numerous, often hundreds, of scoleces. *Coenurus cerebralis* causes the disease known as gid.

In rabbits and hare there is also a cœnurus (*C. serialis*), but only exceptionally in the central nervous system (spinal cord); more frequently, however, in the musculature and in the body cavity.

Cysticercus tenuicollis is a parasite which is frequently found in sheep, pigs and cattle. It represents the larval condition of *Taenia marginata* of the dog. This species is most often met with in sheep and pigs. For example, Olt, in Stettin, found it in 132 out of 500 sheep (26.4 per cent.), and Schwaimair, in Aschaffenburg, in 33 out of 2,009 pigs (1.64 per cent.). *C. tenuicollis* in its earliest stages is elongated, but later becomes rounded and varies in size according to its age. Vesicles are observed of the size of peas and as large as a man's fist, with all intermediate sizes. This larval tapeworm is most frequently found under the peritoneum and pleura and in the lateral layers as well as under the serous covering of the internal organs. The preferred location of this larva is the omentum, mesentery and liver. The younger parasites are located on the surface

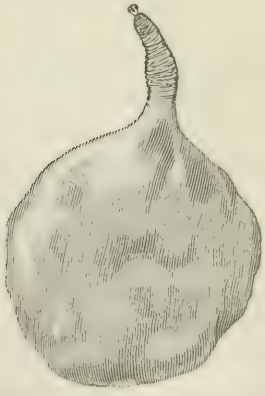
* By some oversight in the German edition the length is stated as .5 to 60 m. —Translator.

of these organs and cause a protuberance of the serous covering (Fig. 99), while the older and larger parasites are located in diverticula of the peritoneum and pleura. *C. tenuicollis* is thus in every instance covered by the peritoneum or pleura. When a section is made into the serous membrane which covers the parasite, the bladder worm emerges. Its chief characters are a long, corrugated neck (Fig. 100), easily protruded by the slight pressure in the fluid of the caudal bladder, and the armed head. The armature consists in a double crown of hooks which are grouped in alternating rows (Fig. 101), the large hooks are from .19 to .20 mm. in length and the small ones from .11 to .12 mm. Both kinds of hooks are slender and furnished with a strongly bent point (Fig. 102). According to Schwarz, the protuberance (basal process) of the small hooks of this species is frequently so decidedly bifurcated as to appear like a thumb nut when seen from in front. The number of the hooks in *C. tenuicollis* is from 32 to 40.

Fig. 99

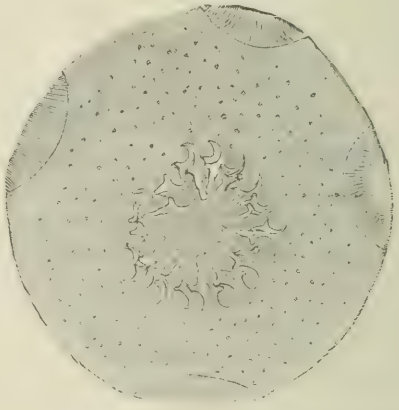
Young Cysticercus tenuicollis *in situ* (after Leuckart).

Fig. 100.



Cysticercus tenuicollis with artificially protruded scolex.

Fig. 101.



Circle of hooks from Cysticercus tenuicolis. From a photograph. × 45 diameters.

In rare cases, *C. tenuicollis* is found also in the parenchyma of the internal organs, especially in the liver. In this situation, however, the parasite, presumably in consequence of the pressure of the surrounding substance of the liver, never reaches a large size. At the most we find intact specimens of the size of a pea. Otherwise it is a normal condition that the larvæ are disintegrated in the

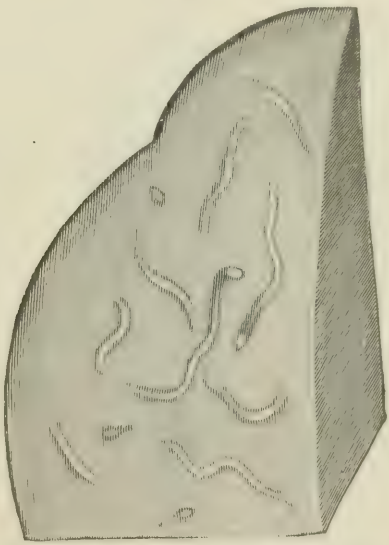
interior of the liver during their early developmental stages in consequence of caseation and calcification, so that only small casefied or calcified tubercles remain.

Finally, mention should be made of the alterations which *C. tenuicollis* may produce in young animals. The parasite develops very rapidly. After twenty-six to twenty-eight days the head is observed, and after thirty-five to thirty-eight days the beginning of the hooks and suctorial apparatus. It is not strange, therefore, that bladder worms may be found in very young animals. Calves, lambs and young pigs, which by any chance have had opportunity to take up the larva of *T. marginata*, show quite considerable alterations,

Fig. 102.

Large and small hooks from C. tenuicollis. From a photograph. × 275 times. The small hook shows cleavage of the basal process.

Fig. 103.



Calf liver with wandering C. tenuicollis.

especially in the liver. The liver exhibits long, coiled passages which are filled with larvæ and detritus of the liver cells, and which are at first dark-red, but later of a brownish or greenish color (Fig. 103). In the expanded end of the passages we may regularly discover the intact or degenerated parasites. More rarely such passages are found in the lungs. It is undoubtedly the soft consistency of the liver tissue of young animals which is favorable to the migration of the larval parasites.

C. tenuicollis, as a rule, is a harmless parasite. It is only when it occurs in large numbers that it may cause death in young animals,

with symptoms of peritonitis or pleuritis. Such cases occur now and then in young pigs.

Differential Diagnosis.—The immature developmental forms of *C. tenuicollis* may be confused with those species which are injurious to health (*C. bovis* and *C. cellulosæ*). It is distinguished, however, from both of these species by its location (in the subserous tissue and internal organs), and by the strong development of its neck. When examined under a microscope, the hooks furnish important diagnostic characters. The beef cysticercus is without hooks, while that of the hog is armed, but possesses fewer and more compressed hooks (see p. 443).

In casefied and calcified *C. tenuicollis* a confusion with tuberculosis is possible. For distinguishing between the two, the condition of the corresponding lymph glands is important. In cases of casefied parasites these glands are intact, while, when tuberculosis is present, they are specifically altered (see p. 344). Moreover, in the caseated material which results from the degeneration of *C. tenuicollis*, hooks and lime corpuscles may be seen by the aid of the microscope (Figs. 101 and 125).

In the hare, the larval stage of *Tænia serrata*, *C. pisiformis*, causes alterations similar to those produced by *C. tenuicollis* in domesticated animals. *C. pisiformis*, however, quite frequently undergoes a caseous degeneration, not only in the interior, but also upon the surface of the internal organs. The cysticercus disease of rabbits may appear in an epizootic form and may give rise to confusion with tuberculosis, in consequence of the caseation of the parasites. Incidentally it should be noted that hunters wrongly called the alteration in question a syphilitic process, or a " venereal disease of the hare."

In bony fishes, according to Guinard, *Tetrarhynchus* larvæ are frequently observed, which may develop further in the alimentary tract of dog fish, rays and sharks. Guinard made a study of cod fish meat which was thoroughly infested with small cysts and resembled measly pork. *Tetrarhynchus* larvæ 3.5 mm. long and 1.5 mm. wide were found in the cysts.

(c) Flukes (Trematodes).

For the purposes of meat inspection the most important flukes are the liver flukes (*Distomum hepaticum* and *D. lanceolatum*). *Amphistomum conicum* may also be mentioned as a less important member of the group of flukes. The latter parasite (Fig. 104) is

from 4 to 12 mm. long, 1 to 3 mm. wide, and usually of a red color. It is found in the paunch of ruminants and is usually a harmless parasite. In Germany the parasite is ordinarily rare, while in hot climates, on the other hand, it is very abundant. According to Janson, it is seen in Japanese cattle in such large numbers that the mucous lining of the paunch appears to be plastered over with the parasites.

Distomum Hepaticum.

Morphology and Occurrence.—The large fluke, *D. hepaticum*, is a leaf-shaped worm with a conical anterior end and a flattened

Fig. 104.

Amphistomum conicum in natural size.

Fig. 105.

Distomum hepaticum. × 2 times.

posterior portion (Fig. 105). It is from 16 to 40 mm. long and 6 to 12 mm. wide. The presence of scale-like spines upon the integument is of special importance in explaining the alterations which *D. hepaticum* may cause. The location of this fluke is in the gall ducts of cattle, sheep, goats and hogs. Occasionally it is also found in the horse (Sauer). Cattle and sheep are most frequently parasitized by this worm. The majority of cattle contain liver flukes or show evidence of their presence, and Schaper asserts that in the slaughterhouse at Munich he found no sheep liver which was free from flukes. Leuckart found similar conditions in certain regions of Holstein.

Wandering Flukes.—The liver fluke is found quite often in the lungs as well as in the liver. They are carried thither in the circulation, and are surrounded by a membrane which is at first of connective tissue, later becomes cartilaginous, and finally incrusted. They lie in a cloudy, often bloody, dark-brown fluid. The fluke tubercles in the lungs may attain the size of a chestnut. The parasites in the lungs, however, commonly remain in a poor condition. Morot found encysted liver flukes in the lungs of 4 per cent. of the cattle which were inspected by him during one half year. Wandering liver flukes may also become located in the retropleural and retroperitoneal tissue, in the spleen, subcutis, skeletal musculature and cardiac chambers, as well as in the lungs.

Pathogenic Importance and Diagnosis.—The symptoms which are produced by this parasite vary exceedingly. When but few are present, they usually produce no noticeable disturbance. In cases of excessive invasion, however, a catarrh of the bile ducts appears, and also an inflammation of the walls of the bile ducts, which may result in a thickening and finally a calcification of the latter. We may observe upon the gastric surface of the liver that the superficial, larger bile ducts are changed in form and become prominent, firm strands or stiff tubes leading to the gall bladder. By making a suitable section under the lobus spigelii, or near the quadrate lobe, and in the middle of the left lobe, the deeper-lying bile ducts may be exposed and will be found to be modified in the same way. The tissue of the liver may remain unchanged in spite of excessive infestation of the larger bile ducts. This must indeed be considered as the usual occurrence. Only exceptionally is the liver tissue itself involved in the disease and then in the form of a proliferation of the connective tissue extending from the adventitia of the bile ducts. This process usually involves the destruction of the liver tissue and leads to an increase in the volume of the organ. At the same time the liver loses its reddish-brown color and becomes gray. Moreover, its consistency becomes firmer, so that it cannot be readily penetrated with the finger (hypertrophic cirrhosis of the liver).

Schaper called attention to the fact that freshly introduced flukes may be found in the peripheral parts of the liver, since they penetrate into the smallest bile ducts by means of their strong, pointed head and their coating of spines, which prevents them from going backwards. Attention should be given to this point in making an inspection.

The tendency of liver flukes to penetrate into the smallest bile ducts, so far as this is possible, is of interest in another regard. It may occur that liver flukes penetrate the thin-walled bile ducts and give rise to hemorrhages of the liver (see p. 294). The flukes which produce such hemorrhages are, as a rule, undeveloped and at most 1 cm. long. Occasionally it happens, but these cases are rare, that a fluke perforates even the liver capsule. In this way so-called biliary peritonitis may be produced (p. 287). The remains of the liver hemorrhages caused by the wandering of the flukes outside of the bile ducts may exhibit several forms. At first the resorption of the blood takes place and this leads to a diminution in the size of the liver. Later, however, an active regeneration of the liver cells appears to take place, so that only slight defects and comparatively few scars are to be observed. Now and then it is noticed that distomatous liver hemorrhages may be connected with a multiple hepatitis with abscess, which is due to the fact that the parasites, in penetrating into the tissue, carried with them putrefactive bacteria.

Peculiarities of Distomatosis in Different Domesticated Animals.—In the first place, it should be observed that the majority of cattle are infested with the liver fluke. It appears that only such cattle as never are allowed upon pasture are protected from infestation; for, as a rule, only quite young cattle and bulls which are, for the most part, kept in stalls, show livers which are free from the flukes. It is remarkable that even the presence of a large number of liver flukes does not ordinarily cause any disturbance in the nutrition of cattle. Marked thickenings of the bile ducts are observed, so that the form of a medusa's head may appear upon the gastric surface of the liver, even in well-nourished animals. Even in connection with cirrhosis of the liver, an injurious effect of liver flukes upon the health of cattle can not usually be demonstrated. So long as a portion of the liver of the size of a double fist is still unaffected, the nutritive condition of infested animals may still be comparatively good. The uninjured portions of the liver are usually enlarged later, like a tumor. The author has never observed hydremic cachexia in slaughtered animals in consequence of distomatosis, even in the youngest animals. The most marked effects of distomatous cirrhosis of the liver are shown in an emaciation of the affected animals.

The conditions are quite different in sheep. In these animals it is a well known fact, which has been substantiated by investiga-

tions in abattoirs, that extensive invasions of the liver fluke cause serious disturbances in the nutrition, acute anemia and finally hydremic cachexia. This occurs, not only in occasional individuals, but even in whole herds (liver fluke epidemic). The injurious effect which extensive invasions of liver fluke may cause in sheep is apparent from the fact that in Alsace-Lorraine in the year 1873 not less than 30 per cent. of the sheep died of liver fluke disease; while in England, as reported by Leuckart, 1,000,000 sheep annually fall a prey to this parasite.

In hogs the liver fluke is a rare occurrence, at least in so far as our native animals are concerned. Pigs which are imported from Hungary, Servia and Russia, however, are frequently infested with the parasites. Disturbances of the fattening process in hogs do not occur as a consequence of distomatosis.

Distomum Lanceolatum.

Pathogenic Importance, Morphology and Occurrence.—*D. lanceolatum*, in comparison with *D. hepaticum*, is a harmless parasite, even in sheep; for, as a rule, it produces only insignificant local symptoms, rarely any of general extent. This fact is explained by the smaller size of the parasite. It measures only 4 to 8 mm. in length and 1 to 2.5 mm. in width. Its harmless nature is further explained by the absence of a coat of spines. *D. lanceolatum* is parasitic in sheep and cattle, less often in goats and hogs. It is not, however, so generally distributed as *D. hepaticum*. Its appearance is rather restricted to certain regions, as, for example, southern Germany and Thüringen. According to Tempel, the sheep slaughtered in Chemnitz are on an average infested to the extent of 90 per cent. with fluke worms. Of these cases of infestation, 75 per cent. are due to *D. hepaticum*, and 25 per cent. to *D. lanceolatum*.

Diagnosis.—The presence even of numerous *D. lanceolatum* may not be observed by the inspector for the reason that the liver tissue remains wholly unchanged and the bile ducts are only slightly affected. Only by the regular practice of cutting open the larger bile ducts and by producing lateral pressure upon them may these fluke worms be brought to notice, for, in spite of its small size, *D. lanceolatum* is quite conspicuous on the cut surface of the bile duct on account of its partial black or brown coloring (the color of the ripe eggs in the unusually well-developed uterus, Fig. 106).

From the important work of Schaper on "The Fluke Worm Diseases of Domesticated Animals," from which citations have already been made, the following interesting details are drawn:

Distomes are pure entozoa. They cannot live in the adult condition outside the body of their definite host. Their embryonic stages are passed, on the other hand, partly in a free condition and partly in smaller host animals of the group of mollusks, mostly water snails of the genus *Limnæa* (Leuckart). From these situations they make their way into the definite host and are there developed into sexually mature parasites. *D. hepaticum* and *D. lanceolatum* occur in rare instances even in man. Man is infected, however, not by eating distomatous livers, but, as is apparent from the biology of the parasites, in the same way as are sheep and cattle. In contrast with *D. hepaticum*, which regularly causes a glandular hyperplasia of the mucous membrane of the bile ducts, *D. lanceolatum*, even in large numbers, does not produce any serious alterations in the liver. The pathological changes which are produced by *D. lanceolatum* are restricted almost entirely to catarrh of the bile ducts.

FIG. 106.

Distomum lanceolatum
a, × 10 times;
b, natural size.

Icterus is a rare occurrence in distomatosis, for the reason that the parasitism of distomes rarely leads to a complete obstruction of the bile ducts. On the other hand, the bile ducts become a "cloacal system," in which the waste products of the liver, together with the metabolic products of the parasites, are found. A diminution in the number of blood corpuscles and in the amount of hemoglobin is usually observed in the blood (see p. 368). The chief cause of the anemic condition is persistent or repeated hemorrhage. "The fluke worm epizootic is to be considered as an especially malignant form of the fluke worm disease, which, by the accidental concurrence of several pathogenic factors, may be characterized by serious secondary phenomena and by a rapid course."

Development of Distomes.—For rendering a legal judgment concerning distomes, the statement of Leuckart is of importance, namely, that the development of the young distomes to maturity requires about three weeks. According to Lutz, specimens of *D.*

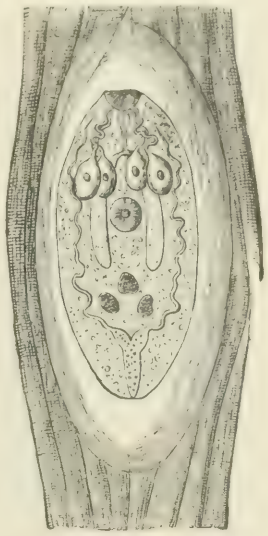
hepaticum eight to nine days of age were 1 to 2 mm. long; twenty-seven to thirty-one days of age, 3 to 8 mm. long; thirty-two days of age, 10 to 15 mm. long; and forty-four days of age, 20 mm. long. Lutz obtained these figures from distomes which he had reared in guinea-pigs.

Judgment on Livers Infested with Flukes.—It has been shown by feeding experiments that feeding distomatous livers to susceptible animals does not bring about a development of the liver fluke as a result. These negative results from feeding experiments are sufficiently explained by the biology of the parasites. The embryos (miracidia) which hatch from the eggs must develop in small snails and in the water into sporocysts, rediæ and cercariæ before they can develop further in the body of their definite host. There can, therefore, be no doubt as to the harmlessness of fluke-infested livers. Therefore, the greatest leniency may be observed in dealing with these livers. It should be remembered that the occurrence of liver flukes in the liver of sheep and cattle is to be considered an almost normal condition. The presence of these parasites in the liver of sheep and cattle cannot be characterized in itself as an important defect, so much the less so since in cases of slight invasion it is possible to remove the parasitized portions by careful dissection of the large, medium sized and small bile ducts. Distomatosis is to be considered as an important defect, giving a right of partial or complete exclusion of the affected organ from the market, when all of the bile ducts, including the small ones, are filled with distomes so that a separation of the bile ducts is impossible. The same condition holds true in extensive cirrhosis—in a partial cirrhosis restricted to one portion of the liver, only the affected part of the liver needs to be excluded from the market—and finally in suppurative inflammation of the liver tissue in consequence of the penetration of flukes into it. Livers which show hemorrhages from distomes are to be considered as of inferior value in the sense of the food law, but may, however, be admitted to the market without compulsory declaration, since the abnormal condition is apparent of itself.

Muscle Distomes.—In the musculature of the hog, Leunis discovered a small undeveloped Agamodistomum. This discovery was later corroborated by other investigators. Thus in inspection for trichinæ in Berlin these peculiar parasites were found in several cases. They have no importance, however, since, as a rule, they

occur only in isolated examples and only in the rarest instances. According to Duncker, the muscle distome is an extremely delicate, thin structure of gray color and of about the size and form of a trichina capsule (Fig. 107). The favorite location of this worm appears to be in the muscles of the diaphragm and larynx. The muscle distomes lie between the muscle fibers. They become active when slightly warmed. This is important in diagnosis for the reason that the parasites at rest show a certain resemblance to Sarcosporidia. Moreover, Duncker proposes the following method of inspection: "In order to inspect meat for distomes, the smallest possible transverse sections should be taken from the bundles of muscle fibers, after which they should be placed upon a slide with plenty of water and covered loosely with the cover glass. Then the water is studied for the purpose of observing whether it contains any of the worms. If the worms are not found in it, attention should be directed to determining whether the amorphous gray structures resembling psorosperms and lying between the muscle fibers, exhibit worm-like movements. If these are observed the crescent-shaped white shining gastric membranes will be seen in their interior. They appear more conspicuously if slight pressure is exerted on the cover glass, with movements back and forth.

Fig. 107.



Muscle distome of the hog (Leuckart). × 80 times.

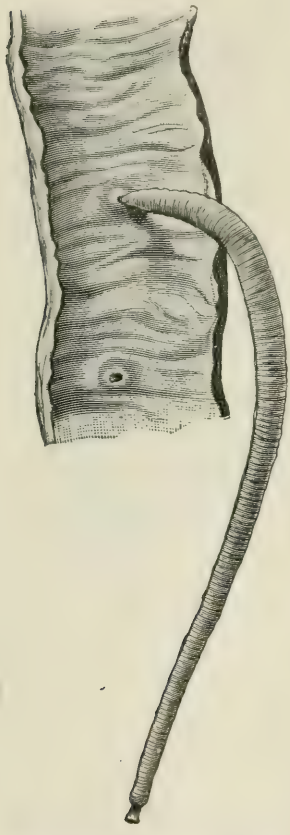
Distomes in Foreign Animals—In Sicily, *Bilharzia crassa* is found in the abdominal veins of cattle; in America, *Distomum magnum* in the liver of cattle; in America and Japan, *Mesogonimus Westermanni* in the lungs of hogs; and in Japan, *Distomum pancreaticum* in the pancreas of cattle.

(d) Round Worms (Nemathelminthes).

The round worms are divided into two large groups, the thread worms or nematodes, and Acanthocephali, of which the only representative is the giant Echinorynchus of the hog.

Echinorynchus gigas (male, 6.5 to 9.1 cm. in length; female, 31.2 to 41.6 cm., Fig. 108) is distinguished by the fact that it possesses a conical beak furnished with horny barbed hooks in several rows upon the anterior end of the body. It lives in the small intestine of the hog and causes there a limited area of inflammation which, on account of its yellow color, may be confounded with tuberculous patches. In exceptional cases it has been observed that the parasite bored through the mucous membrane of the intestine and gave rise to peritonitis.

Fig. 108.



Echinorhynchus gigas on the small intestine of a hog. Natural size.

The nematodes, according to Schneider, are to be divided into three groups:

(1) Polymyaria (*Ascaris*, *Eustrongylus*, *Filaria*); (2) Meromyaria (*Oxyuris*, *Strongylus*); (3) Holomyaria (*Anguillula*, *Trichina spiralis*, *Trichocephalus*).

Of the large number of nematodes in domestic animals there is only one subdivision, viz., that of the palisade worms (Strongylidæ), which deserves any detailed consideration in this connection. With regard to the others, a short statement of their name, position and size must suffice, on account of their slight sanitary importance.

The Ascaridæ (*Ascaris megalocephala*, in the horse; *A. lumbricoides* in cattle and hogs) live in the intestine and produce only exceptionally, in cases of excessive infestation, a disease of the affected animals. Isolated specimens may be occasionally found in the common bile duct and may cause icterus by retention of the bile. Such cases are not rare in hogs. Judgment of the meat should be the same as in icterus. Morot, Laubion, Leibenger, have, moreover, observed that the meat of calves which contain numerous ascarids in the intestines may have an acid odor and taste. The odor does not disappear even when the meat is preserved for several days. In such cases the meat is to be considered as of inferior value and is to be sold upon the freibank if the abnormal odor becomes conspicuous in a boiling test.

In fowls, diseased areas of considerable size are observed in consequence of the presence of an abundance of ascarids (*Heterakis vesicularis, H. inflexa, H. maculosa*). In the musculature of codfish, *Ascaris capsularis* is found as an encapsuled parasite, varying in length from 2 to 5 cm. In the stomach of Hungarian and Russian hogs a nematode occurs which Fedtschenko named *Gnathostomum hispidum*. This author found the parasites in the stomach of a Turkestan wild hog and a Hungarian domestic hog, while Csokor found it in hogs slaughtered in Vienna; Ströse in Bakonyi hogs and Collin in the fat tissue of cattle. According to Csokor, the parasite may cause a stomach worm disease of hogs. By means of its bristle-bearing head it may bore into the serous coat of the stomach wall and cause a considerable swelling of the mucous membrane of the stomach. The Vienna butchers have long known the parasite under the name "three-colored worm." According to Ströse, the male is 15 mm. and the female 22 to 25 mm. long. The parasite is from 1.18 to 1.38 mm. thick in the male and 1.78 to 1.85 mm. in the female.

Moreover, attention should be called to the giant palisade worm (*Eustrongylus gigas*) in the renal pelvis of the dog, horse and domestic ox.

Of the filariæ (thread worms in the narrower sense), the following are worthy of mention: *F. microstoma* and *F. megastoma* in the stomach of the horse; *F. hemorrhagica* in the subcutis and in the intermuscular tissue of the horse; *F. strongylina* in the stomach of the hog; *F. scutata* in the esophagus of cattle and sheep, and perhaps also under the epithelium of the tongue and in the mucous membrane and esophagus of hogs (Korzil); and *F. immitis* in the venous system of the dog.

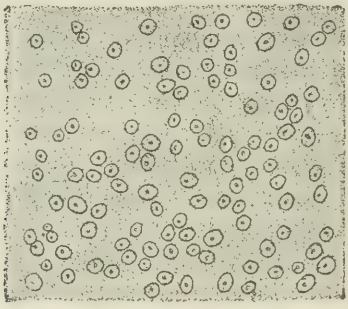
In geese and ducks, *Dispharagus uncinatus* may be parasitic in tubercles in the esophagus and may cause a so-called filaria disease of fowls. In the tubercles, we find younger and older parasites from 3 to 18 mm. in length. Rabieaux observed an epidemic among fowls which was caused by *Filaria pectinifera* (male, 5 to 6 mm.; female, 9 to 10 mm. in length). This parasite was located in the gizzard of fowls. Moreover, *Syngamus trachealis* may produce epizootic losses among fowls. The parasites are located, the male and female united, in the trachea and in the esophagus. The males are 2 to 6 mm. in length and the females 5 to 22 mm. and from .2 to 1.1 wide. The undeveloped worms which have not yet been differentiated into sexes may be found in the air sacs and the bronchi.

Strongylidæ.

The Strongylidæ or palisade worms are round, rarely thread-like or hair-like worms of varying size. Their course of development, which, aside from the fact that the Strongylidæ of domesticated animals have not been found in man, with one exception, presents considerable of interest, is of such a nature that the possibility of transmission of the worms, by eating organs which are infested with them, is absolutely excluded. The embryos pass a free worm stage (rhabditis form) outside of the animal body, and are taken up by susceptible animals with water or moist plants.

Among the palisade worms of less sanitary importance, mention may be made of *S. armatus* in the large intestine and cecum and in aneurisms of the abdominal blood vessels, especially of the anterior

Fig. 109.



Fourth stomach of beef infested with Strongylus convolutus.

mesenteric artery of the horse; *S. hypostomus*, in the stomach of sheep and goats; *S. cernuus*, in the alimentary tract of sheep; *S. radiatus* and *ventricosus*, in the small intestines of cattle; *S. dentatus*, in the large intestine of hogs; *S. inflatus*, in the large intestine of cattle; *S. venulosus*, in the intestines of goats; and, finally, *S. filicollis*, in the duodenum of sheep and goats.

Greater importance attaches to those Strongylidæ which may disturb the general condition and the nutrition of food animals or may produce serious alterations in the organs which are utilized as human food. To this group belong the palisade worms of the stomach and lungs.

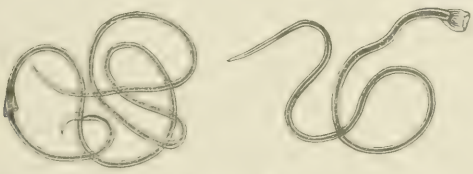
Palisade Worms of the Stomach.

In the fourth stomach of sheep and goats, *Strongylus contortus* lives parasitically (male, 13 to 15 mm.; female, 20 to 25 mm.

long). The parasite obtains its nourishment from the blood of the host, and in young animals may produce emaciation and hydremic cachexia (stomach worm disease) in cases of excessive invasion.

In the fourth stomach of cattle, the author found *S. convolutus* (male, 3 to 9 mm.; female, 4 to 12 mm. long) (Fig. 110). The female is characterized by the possession of a bell-shaped duplicature of the skin over the vulva and may thus be distinguished from similar Strongylidæ. *S. convolutus* is a very frequent parasite in cattle. In the abattoir at Berlin, it was found in 90 per cent. of all cattle which were slaughtered, including all cases in which isolated examples occurred. The coiled worm lies under the epithelium of the mucous membrane of the stomach and produces in that location small projections about the size of lentils provided with a central opening (Fig. 109). According to the observations of the author, *S. convolutus*, in cases of excessive invasion of young cattle, may produce a considerable diminution of the digestive surface of the stomach and

FIG. 110.



Strongylus convolutus, female on the left, male on the right. × 10 times.

thereby cause emaciation or dropsical symptoms in unfavorable cases. According to the accounts of Smith and Stiles, the latter of whom proposes the name *S. ostertagi* for the parasite, since *S. convolutus* was already preoccupied for another parasite, the nematode in question is very common in North America. Furthermore, McFadyean found *S. convolutus* in young cattle which had become emaciated and anemic with symptoms of diarrhea. After death, or after the slaughter of the animals, an inflammation of the mucous membrane of the fourth stomach was found, and in such locations *S. convolutus* was found not infrequently associated with *S. retortæformis*.

According to Stödter, in addition to *S. contortus* and *S. convolutus* five other species of Strongylidæ which have the power of producing serious disease, are found in the fourth stomach of domesticated ruminants. These species are *S. curticei* (male, 6 to 8 mm.; female, 10 to 13 mm. long), in cattle and sheep; *S. oncophorus* (male, 7 to 9

mm.; female, 9 to 12 mm. long), in cattle; *S. harkeri* (male, 8 to 9 mm.; female, 15 to 16 mm. long), in cattle; *S. retortæformis* (male, 3 to 7 mm.; female, 3 to 9 mm. long), in cattle, sheep, goats and also in the fallow deer, hare and rabbits; and *S. filicollis* (male, 8 to 15 mm.; female, 16 to 24 mm. long), in sheep.

Ströse found *Anchylostomum longemucronatum* in the small intestine of a hog which was slaughtered on account of disturbances in nutrition, and on account of the protuberance (thickening) which he found in the wall of the intestine was inclined to consider the parasite as responsible for the nutritive disturbances in the host.

In hare and wild rabbits, *S. strigosus* and *S. retortæformis* may, according to Railliet, occur in the stomach and intestines and may produce serious symptoms of disease.

The Palisade Worms of the Lungs.

To the palisade worms of the lungs belong *S. micrurus* in cattle, roebuck and fallow deer *; *S. filaria*, *S. capillaris* and *S. commutatus* in sheep and goats, as well as *S. paradoxus* in hogs. These palisade worms, after being introduced into the host, become located in the smaller and minute bronchi and alveoli, and by means of the irritation which is exercised by them, they may cause a bronchitis or bronchiolitis. The embryos of the palisade worms, which become mature in the bronchi and reproduce oviparously or viviparously, penetrate into the lung tissue and thus cause a lobular or even a diffuse broncho-pneumonia (compare p. 325). Broncho-pneumonia may lead to the death of the infected animals. When recovery begins, the embryos wander back into the bronchi and from here pass either directly or by way of the alimentary canal, to the outside world. According to Müller, the embryos of the palisade worms usually lie nearer the trachea and larynx as they become larger in size. The parent animals are disintegrated in the lungs. They may become encysted and casefied or calcified inside of the connective tissue capsule.

Strongylus micrurus is viviparous. The male is about 30 to 40 mm., the female, 40 to 80 mm. long. The females are especially conspicuous on account of their milk-white, oily appearance. Their location is in the bronchi, preferably those at the base of the lungs. *S. micrurus* is in general a rare parasite in cattle. Only in certain

* Müller is of the opinion that the fallow deer is the common host of *S. micrurus*, while cattle are only exceptionally infested.

regions—for example, in the marshy districts of Oldenburg and in the lowlands of the Rhine—does it occur abundantly in wet seasons.

In the case of slight invasion we observe in the superficial parts of the lungs which are infested with these parasites, white lobuli with a sheen like that of mother-of-pearl, which do not collapse and which feel firmer than the normal tissue (Fig. 113). In making a section into these places, the parasites are found in the smaller bronchi, which, as a rule, are pathologically enlarged. The parasites are surrounded by a catarrhal secretion. The author has frequently observed, in the lungs of cattle, dead Strongylidæ which which were enclosed in greenish-colored tubercles.

In cases of excessive invasion in cattle, roebuck and fallow deer, acute broncho-pneumonia may develop with fatal results. In animals which die in consequence of acute pneumonia we frequently find, as was stated by Kitt, only a few developed parasites in the trachea, while large numbers of them are to be demonstrated in microscopical preparations from the inflamed lung tissue.

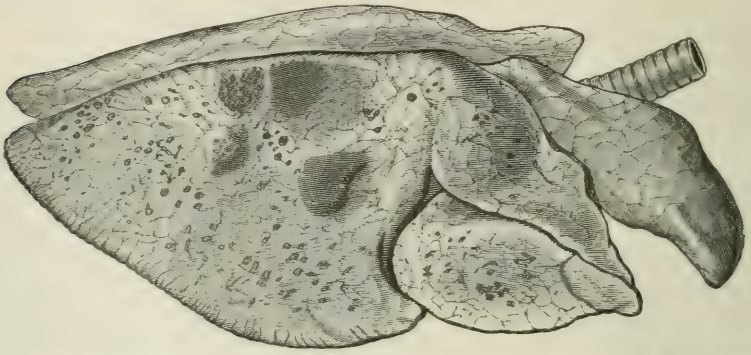
According to Tapken, the migration of the larval worms into young cattle takes place in July and August. The development of the worm is completed within six to seven weeks. During this time the invasion of the worms in acute cases of lung worm disease may cause the death of the affected animals. Winter observed the appearance of the lung worm disease in the meadows of the lowlands along the Rhine. Healthy calves became seriously affected within two weeks. In animals which died within a short time of broncho-pneumonia, no fully developed worms were found. They were observed, however, in animals which were slaughtered after being sick for one to one and one-half months.

STRONGYLUS FILARIA, the lung thread worm (male, 25 mm. long, the female as long as 84 mm.). With regard to the pathological anatomical relations of this worm, the same statements may be made as for *S. micrurus*. It is also apparent in verminous pneumonia of sheep and goats caused by *S. filaria*, that only a few mature specimens of the worm are found in the bronchi and lung tissue of the diseased animals, while immense numbers of embryos and eggs are found. Moreover, *S. filaria* is a comparatively rare parasite in sheep and goats.

STRONGYLUS CAPILLARIS, the lung hair worm (male, 12 mm.; female, 20 mm. long; very slender, almost like a cobweb, .04 to .06 mm. thick). By microscopical examination the male is recognized

by the corkscrew-like posterior end of the body and the yellowish-brown spicules, while the female is distinguished by the two uteri filled with brownish eggs covered with shells. The mature animals live at first in the smaller bronchi of the alveoli and produce an acute catarrhal or hemorrhagic bronchitis. The embryos, after hatching from the eggs, migrate in large numbers into the lung tissue and cause either a limited lobular or more extended bronchopneumonia which may cause death within a short time. Commonly, however, the inflammatory alterations in the lungs gradually recover as the larvæ are expelled by coughing, and the parent worms migrate into the lung tissue, so that only a partial capillary bronchitis remains, which may heal by caseation and calcification of the worms.

Fig. 111.



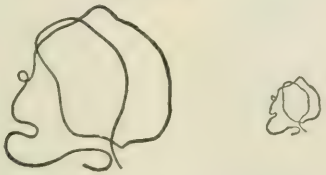
Sheep lung with lobular infiltrations and residual tubercles as a result of invasion by Strongylus capillaris.

The tubercles enclosing *S. capillaris* are to be recognized by their yellow, grayish-red or grayish-yellow color. The worms which are expelled by coughing are swallowed again and may produce in their passage through the alimentary tract an acute catarrh of the fourth stomach by mechanical irritation (Schlegel).

S. capillaris, according to Schlegel, is most abundant in goats and is rare in sheep, in the latter of which it is often associated with *S. commutatus*. Schlegel has also found *S. capillaris*, *S. commutatus* and *S. filaria* in one and the same animal. The goat, however, is the true host of *S. capillaris*. Among 200 goats slaughtered at the abattoir in Freiburg, Schlegel found about 30 per cent. to be infested with *S. capillaris*. Ruser, in 1891, found the parasite in 19.5 per cent. of the sheep which were slaughtered at the abattoir at Kiel. In the course of the invasion of *S. capillaris*,

we find in the lungs, as already stated, a tubercular, lobular infiltration of a gray or grayish-yellow color. Later, however, there are more or less numerous tubercles, in size varying from a millet seed to that of a lentil or pea, and of a yellow, grayish-red, or grayish-yellow color (Fig. 111). The larger of these tubercles show a certain resemblance to the tubercles of tuberculosis, since they ordinarily possess a cloudy-white or yellow center. In the tubercles the extremely friable, dead, old worms, or aspirated eggs and embryos, are found (Schlegel), while the wedge-shaped, pneumonic infiltrations, corresponding to the bronchial branches, contain numerous coiled bodies of worms, as well as eggs and embryos, the latter frequently lying close together as if in a nest (Fig. 78). Koch called attention to the fact that in November he frequently found eggs and embryos in the lung tissue and in later months only the encapsuled parent animals. In this fact we have a characteristic difference between the lung hair-worm disease and the lung thread-

FIG. 112.



Strongylus capillaris from the sheep lung; fully developed specimen. Natural size at the right.

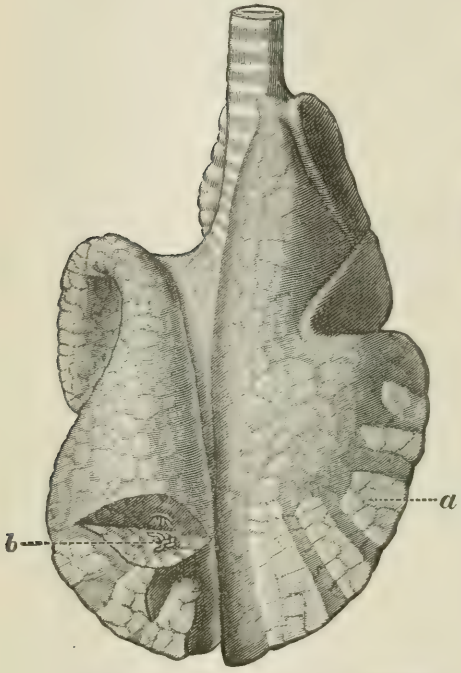
worm disease (A. Müller). *S. capillaris* always penetrates in large numbers into the lung tissue and remains there, finally becoming encapsuled and dying in the capsules. *S. filaria*, on the other hand, turns back, in case it ever leaves the bronchi, and migrates to the outside world through the trachea.

In the lungs of hare and rabbits, *S. commutatus* is found as a parasite. This thread worm, which possesses a length of from 30 to 70 mm. and is distinguished by its brown color (due to the dark pigmented intestine), is always found in greater or less numbers in the lung tissue and causes a limited area of inflammation. The inflammatory patches are of the size of a hemp seed or hazel nut and contain yellow, caseous material in addition to the parasites. *S. commutatus* may cause an epizootic among hare. As Schlegel demonstrated, *S. commutatus* is comparatively frequent also in sheep. Indeed, Schlegel characterizes *S. commutatus* as the most frequent and most injurious lung worm of sheep. According to Schlegel, the

dark-brown, black, reddish-violet or reddish-brown tubercles in the lungs of sheep always contain *S. commutatus* in an encysted condition.

STRONGYLUS PARADOXUS, 16 to 20 mm. long in the male and 30 to 40 mm. long in the female, is a very common parasite, but in spite of its large numbers, causes only slight disturbances in its host.

FIG. 113.



Hog lungs with Strongylus paradoxus. *a*, pearly parasitic foci; *b*, parasites in a section of a bronchus.

FIG. 114.

Strongylus paradoxus in an opened bronchial branch.

According to my investigations, *S. paradoxus* was present in about 60 per cent. of the hogs which I inspected at the Berlin abattoir. According to investigations in Leipsic, Mejer estimates its occurrence in native hogs at 19 per cent. and in Hungarian hogs at 52 per cent. The invasions are rendered conspicuous from a distance by the spots, resembling mother of pearl, at the base of the lungs (Fig. 113). The bronchi which lead to these spots are enlarged and as a rule filled with knotted worms (Fig. 114). In about 90 per cent. of the cases, according to the author's observations, the

invasion is restricted to the base of the lungs; in the remaining 10 per cent., larger portions, sometimes even the greater part of the lung up to the apex, are infested with the parasites. *S. paradoxus*, as a rule, causes only a catarrhal bronchitis and bronchiectasis, but no pneumonia.

Olt described the finer anatomical changes which *S. paradoxus* produces in the lungs of hogs. According to this author, the parasite causes a desquamative bronchitis with hyperplasia and ectasis of the tubular glands in the mucous membrane of the bronchi and hypertrophy of the bronchial mucous membrane. Moreover, bronchiectasis and parasitic tubercle formation occur in the bronchi (bronchitis and nodular chronic peri-bronchitis), as well as in the lung tissues, and these tubercles resemble in every particular the entozoic tubercles in horses' lungs (p. 328). Finally, according to Olt, in consequence of the parasitism of *S. paradoxus*, lobular desquamative pneumonia may arise with ultimate recovery or a connective tissue induration, as well as small pneumonic areas which become casefied with a secondary localization of vegetable organisms.

Little-Known Round Worms of Food Animals.

Leuckart described a small encapsuled round worm resembling trichina, which was found in melanotic lymph glands in a beef animal. The worm was asexual and 0.14 mm. long.

The nematodes which were discovered by Drechsler in the small intestine of cattle have already been described in connection with the parasitic Œsophagostomum on page 283; similarly the round worm discovered by Natterer in the kidney fat capsule of a hog (*Sclerostomum pinguicola*), and the non-glanderous lung tubercles of the horse, which were shown by Olt and Grips to contain nematodes (pp. 309 and 328).

In the mucous membrane of the intestines of hogs there are, according to Johne, small encapsuled larval worms resembling trichina. Johne considered them as belonging to the palisade worms. With reference to the Strongylidæ discovered by Olt in the follicles of the large intestines in hogs, compare p. 283.

In one instance, Kitt found a nematode under the epithelium and between the papillæ of the mucous membrane of the tongue in a hog. Leuckart considered that this was probably a true filaria (compare also the observation of Korzil, p. 407).

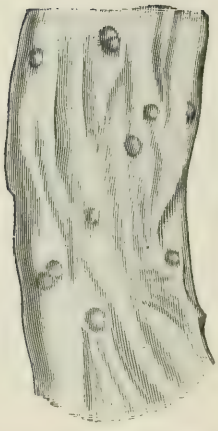
Finally, Ebertz reported concerning the finding of a parasite in the musculature and lungs of a sheep. This find requires further

explanation. A butcher had jokingly requested a trichina inspector, recently appointed to office, to inspect the meat of a young sheep which during life had exhibited a poor nutritive condition, muscular trembling and coughing. The trichina inspector removed the diaphragm, loin muscles and muscles of the shoulder, as well as the diseased portions of the lungs, and by an investigation demonstrated the presence of numerous parasites which closely resembled migrating muscle trichinæ, but were distinguished from them by their smaller size and greater transparency. Leuckart declared

Fig. 116.

Larva of Anchylostomum bovis from submucous tubercles of bovine intestine (after Ströse), × 25 times.

Fig. [illegible]



Small intestine of beef with submucous nematode tubercles.

that these parasites were the larval form of a filaria or of some strongylid, a nematode which probably was viviparous when parasitic in sheep. Concerning the significance of the find, Leuckart stated: "I do not believe that the worm can be transmitted to man, although, on the other hand, I would not desire to assert the impossibility of such transmission." According to the view of the author, it is impossible to avoid suspecting that the parasites which were alleged to have been found in the musculature of the sheep

came from the lungs and were allowed to get into the muscles by improper preparation of the material for inspection.

Sanitary Significance of Organs Infested with Parasites Which Are Non-Transmissible to Man.—In the unusually frequent occurrence of such parasites in the internal organs of food animals, it is required, from the standpoint of national economy—and this is never opposed to hygienic interests—that as many as possible of the parasitized organs should be put in a condition fit for consumption by the careful removal of the parasites. In cases of slight invasion, when the integrity of the parenchyma of the organ is still preserved, there is no reason for restricting free traffic in the organ. Only in case of excessive invasion are the remains of the organ to be considered as inferior food material, after the removal of the parasite. On the other hand, all internal organs which show extensive inflammatory changes in consequence of invasion by worms, or which show these changes in a degree which render removal of the worms impossible, are to be absolutely excluded from the market as unfit for food.

2.—Parasites Which May Be Transmitted to Man by Eating Meat.

There are three parasites of ordinary food animals which may be transmitted to man by eating meat:

(1) Beef bladder worm (*Cysticercus bovis*); (2) pork bladder worm (*C. cellulosæ*); (3) trichina (*Trichina spiralis*).

The new measle worm of the sheep (*C. ovis*), which is supposed to be dangerous to health and concerning which Cobbold has assumed that it develops into a new tapeworm (*Taenia hydatigena*) in man, has been declared by the Paris Academy of Sciences to be *C. tenuicollis*. The frequent occurrence of tapeworm among the Arabians, who use mutton as their chief meat food, has no connection with this food. The Algerian tapeworm is, in fact, *T. saginata*, and comes from cattle. Leuckart considers the bladder worm found by Cobbold in mutton as *C. cellulosæ* (with twenty-six hooks). This assumption is, according to the newer discoveries concerning *C. cellulosæ* in sheep, to be considered as well founded (Olt, Bongert), despite the fact that Leuckart did not succeed in artificially rearing *C. cellulosæ* in sheep.

Dangerous Fish Parasites.—In addition to cattle and hogs, fish also contain dangerous bladder worms, the larval stages (plerocerci) of *Bothriocephalus latus*.

Occurrence.—Braun discovered the larval stages of *B. latus* in the musculature and in various internal organs of the pike (*Esox lucius*) and the eel pout (*Lota vulgaris*). These fish are often eaten incompletely roasted or only slightly smoked. According to Braun, the larval stage of *B. latus* may also be transmitted to man by eating caviar from pike. The larval stages of *B. latus* are in some regions remarkably abundant. Thus in Dorpat Braun found all pike infested. The same was true for the pike brought to the St. Petersburg market from the Finnish Meerbusen and Ladoga Lake. Recently Braun has demonstrated that the pike and eel pout of Königsberg, which come from Frisches Haff and Kurisches Haff, frequently contain the larval stages of *B. latus*. Zschokke, in Geneva, found a larva of this worm in perch (*Perca fluviatilis*), in a trout (*Trutta vulgaris*), in various species of salmon, and in the grayling (*Thymallus vulgaris* and *T. lacustris*). Schröder in Dorpat also found the larvæ of *B. latus* in perch in twenty-eight out of eighty specimens which he examined (35 per cent.).

Concerning the geographical distribution of *B. latus*, Braun states that in Europe there are two centers of distribution: French Switzerland and German Baltic Provinces of Russia. From French Switzerland the species spread into the neighboring districts of France and Italy (Lombardy and Piedmont), while from the Baltic provinces the distribution extended eastward over Ingermannland towards St. Petersburg, and northerly over Finland towards Sweden, and also southerly toward Moscow and Poland, while another race of the worm extended westerly to the Prussian coasts and passed from here to Denmark and the coast of the North Sea. In the last named region *B. latus* is very rare, but is occasionally met with (Holland, Belgium, North of France, Ireland). In Japan, *B. latus* is the most frequent parasite of man.

In Germany, *B. latus* is found most abundantly, according to Braun, close to the Baltic Sea, especially among the inhabitants of the Kurisches Nehrung. It is not rare, however, in Königsberg and East Prussia. A special colony of them, according to Bollinger, has existed for fifteen years on Lake Starnberg, where the larvæ of *B. latus* was undoubtedly carried by travellers.

In the neighborhood of Bienne, Neufchatel, Murten and Geneva Lakes, the inhabitants were infested with *B. latus* to the extent of 10 to 20 per cent., according to Zaeslin. According to Odier, one-

fourth of all the inhabitants in Geneva were formerly infested with this tapeworm. According to Zschokke, the species is at present becoming much rarer in Geneva (1 per cent.).

Demonstration of the Larvæ of Bothriocephali.—The larvæ may be most easily demonstrated in the intestines of the eel pout, especially in the pyloric appendages. They are, however, to be recognized in the musculature by their white color and transparent surrounding tissue. The larvæ are .25 to .30 mm. long. The larger ones lie curved or rolled up in small cavities of the muscles and internal organs and are not surrounded by a capsule. As a rule, the larvæ carry the head drawn in while at rest, but protrude it when warmed up (Fig. 117).

Prevention.—Fish infested with the larvæ of *B. latus* are to be considered as dangerous food material. The tapeworms which develop in men from the larval forms found in fish may cause gastric disturbances or nervous troubles as the result of reflex influences (especially disturbances of sight). Finally, the species, on account of its hemolytic action, may cause acute anemia, which disappears as soon as the worm is expelled. It is, however, impossible to exclude all these fish from sale, since their inspection for the presence of larval tapeworm is impracticable. The sanitary police must therefore restrict its activity to warning by means of public announcements against the consumption of raw pike, eel pout and pike caviar in infected districts.

With reference to the transmission of *B. latus* to man, the observation of Schauinsland is of interest, to the effect that in the Kurisches Nehrung the internal organs of the eel pout, preferably the pyloric appendages, are used in a slightly dried condition as a proprietary remedy against stomach troubles.

(a) Beef Bladder Worm (Cysticercus bovis).

Nature.—The beef measle worm is the larva of *Tænia saginata* of man. This tapeworm is 7 to 8 m. long and possesses mature proglottides which resemble pumpkin seeds and of which the uterus shows twenty to thirty-five lateral branches on each side. The beef measle worm, like the tapeworm which develops from it, is unarmed and has therefore also been called *C. inermis* to distinguish it from the armed pork measle worm.

Historical.—After Linnaeus, in 1767, and Pallas, in 1781, had seen parts of *T. saginata*, Göze described the parasite in 1782. In

1802 Brera described it under the name *T. inermis*, and Küchenmeister, in 1855, called it *T. mediocanellata*.

The tapeworms in man have been known for a long time. The larval forms were also known, but were considered to be tumors or hydatids until comparatively recently, when, in 1684, Redi in Italy, Hartmann and Wepfer in Germany, demonstrated the animal nature of the larval stages from their movements and organization. Küchenmeister, however, was the first person who, about the middle of the nineteenth century, determined by successful experiments that the bladder worms always represented the developmental stages of tapeworms.

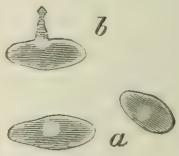
Fig. 118.

Beef bladder worm in natural position and size.

Fig. 117.

Larvæ of Bothriocephalus latus from the musculature of the burbot.

Fig. 119.



Isolated beef bladder worms.
a, with scolex in natural position; *b*, with scolex artificially protruded.

The connection between the beef measle worm and *T. saginata* was demonstrated by Leuckart; in 1861 Leuckart fed calves with proglottides of *T. saginata* and thereby rendered the experimental animals measly. This experiment was made with the same result by Mosler, Cobbold, Simmonds, Röll, Gerlach, Zürn, Pütz, Perroncito, Hertwig and others. The attempt to infest other animals than cattle was unsuccessful. Only Zenker and Heller were able in exceptional cases to cultivate the worms in young goats and sheep.

On the other hand, Oliver (1869), and Perroncito, with his students, brought *T. saginata* to maturity by eating the meat of measly cattle.

Before these decisive experiments, physicians had observed that patients, especially children who were given sliced beef in a raw condition for the purpose of furnishing more nutriment, became infested with *T. saginata*. Moreover, it was known that the Jews, who do not eat pork, suffered especially from *T. saginata*, and finally, it was discovered that certain peoples which eat beef exclusively, as, for instance, the Abysinnians, to whom raw beef is the greatest delicacy, were very frequently infested with the tapeworm in question. These observations and experiments led Leuckart to his classical experiment (Braun).

Morphology.—The beef measle worm consists of a roundish or somewhat elongated bladder, which is located in the interfibrillar connective tissue of the striated musculature, and exceptionally also

Fig. 120.

Beef bladder worm without cyst, 4 weeks old. × 10 times (after Hertwig).

Fig. 121.

Beef bladder worm without cyst, 6 weeks old. × 10 times (after Hertwig).

in certain internal organs, such as the lungs, liver and brain, as well as in the lymph glands.

The bladder is gray, transparent, and consists of an outer connective tissue membrane produced by reaction against the surrounding tissue, the so-called bladder worm capsule, and of the parasite itself. The latter consists of a scolex (head and neck), and the so-called caudal bladder filled with a fluid (Figs. 119, *b*, and 120). The scolex, which is regularly invaginated into the caudal bladder, shines through the capsule as a white structure, varying in size from that of a millet seed to that of a hemp seed (Fig. 118). By making a microscopic examination it is found that the scolex

possesses four sucking disks,* and the so-called neck exhibits numerous lime corpuscles. Hooks are absent.

The size of the cysticerci which occur in food animals varies. They are found from the size of a pinhead to that of peas, according to the developmental stage in which the larval worms are found at the time of the slaughter of their host. Very interesting results concerning the size and developmental relations of beef measles in different ages were obtained from feeding experiments which were instituted by Leuckart, Gerlach, Zürn, Pütz and Hertwig in

Fig. 122

Scolex of a beef bladder worm, 14 weeks old, × 10 times (after Hertwig).

Fig. 123.

Scolex of a beef bladder worm, 28 weeks old, × 10 times (after Hertwig).

calves, with *T. saginata* in a larval condition. Hertwig, in connection with a thorough review of the literature, presented a complete account of the conditions in question (*Ztschr. Fleisch u. Milchyg., Vol. I*). According to Hertwig, the development of the beef measle worm required eighteen weeks. Moreover, the larval worm in the experiments of Hertwig when regularly removed in different stages, showed the following conditions of size:

* Exceptionally, there may be six sucking disks.

Date	Age of Larvæ in weeks	Larvæ		Cysticerci without cyst		Scolex	
		Length	Breadth	Length	Breadth	Natural size	Length when artificially stretched
1890		mm.	mm.	mm.	mm.		mm.
August 12	4	4.0	3.5	2.25	2.25	0.5 mm. diameter	0.7
" 26	6	4.2	3.5	3.0	2.5	1 mm. diameter	1.3
Sept. 9	8	4.5	3.5	3.25	2.75	1.5 mm. long; 1 mm. broad	2.9
" 23	10	5	3.75–4	3.5	3.5	1.75 mm. long; 1 mm. broad	3.3
Oct. 7	12	5–6	3.5–4	4	4	1.8 mm. long; 1 mm. broad	3.5
" 21	14	6	4.5	5	4.5	2 mm. long; 1 mm. broad	4
Nov. 4	16	6	4.5	5	4.5	2 mm. long; 1 mm. broad	4.25
" 18	18	6.25–7	4.5	6	4	2 mm. long; 1.25 mm. broad	5
Dec. 16	22	6.5–8	4.5	6	4.5	2.25 mm. long; 1.75 mm. broad	5.5—6.25
1891							
Jan. 27	28	7.5–9	5.5	7	5	2.5 mm. long; 2 mm. broad	7

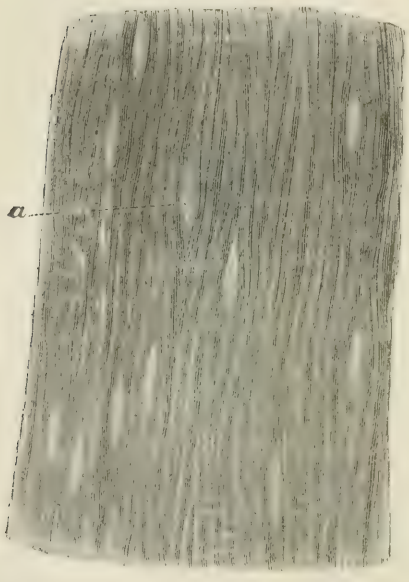
Unusual Findings of Cysticerci.—In addition to the transparent vesicles with plainly recognizable beginning of a scolex, we occasionally meet with structures which in spite of their undoubted cysticercal nature show considerable variation from the usual morphological condition of the beef measle worm.

We frequently find structures of the size of an oat grain up to that of a pea, with thick, opaque, tough wall and with only a small cysticercus (Fig. 124). In such cases we have to do with an unusually strong reaction of the surrounding tissue after the penetration of the tapeworm embryos. The cysticercus may be intact or may be attached to the cyst by means of a fibrinous exudate (fibrinous

inflammation of the inner membrane of the cyst). The same inflammatory process may, however, appear in otherwise normally developed embryos during the various developmental stages and may cause the death of the parasite. Furthermore, the suppuration of the cysticerci has already been observed, apparently due to the introduction of purulent bacteria with the wandering embryos; or to the excretion of these bacteria from the blood into the cysts, as has been experimentally demonstrated by Fränkel.

Furthermore, we frequently find among beef measle worms simple regressive metamorphoses not due to inflammatory processes. They begin with a coagulation necrosis, which appears in the caudal vesicle and becomes conspicuous as a caseation. The caseation passes gradually into calcification. During this process the cyst, as a rule, remains intact. The regressive metamorphoses may appear in beef measle worms in every developmental stage. It is erroneous to suppose that only old, fully developed cysticerci are subject to caseation and calcification. Moreover, attention should be called to the fact that all of the cysticerci in a particular animal may undergo the above mentioned regressive metamorphoses, but that this is not necessarily the case. It is particularly true of the cysticerci which are located in the internal organs; for example, the cardiac cysticerci. I have called attention in another place to the fact that degenerated tapeworm larvæ may be found in a completely intact condition in the voluntary muscles. Kallmann called attention to the peculiar fact that the casefied larval tapeworms are frequently distinguished by their greenish color.

Fig. 124.



Young beef bladder worms with strong development of the capsule. At *a* the scolex shows through the capsule. Natural size.

Occurrence.—The beef measle worm was formerly considered a rare parasite in Europe. In certain tropical countries, as, for

example, Abyssinia, it was well known, on the other hand, that this worm was of very common occurrence in cattle. The rarity of beef measle worms among the native cattle of Europe was quite striking, for it stood in unexplainable contrast to the frequency of the appearance of *Tænia saginata* in man. Physicians uniformly reported concerning the decrease in numbers of *T. solium*, the tapeworm which develops from pork measles, while *T. saginata* not only did not decrease, but was on the increase.

According to Zäslin, *T. saginata* at the present time occurs in Switzerland from nine to ten times more frequently than the previously equally common, if not more common, *T. solium*. Roth in Basel, in 1,526 autopsies, found *T. solium* in no case and *T. saginata* in eleven cases. In Tübingen, Vierordt, in an examination of eleven tapeworm patients, found *T. saginata* in nine cases and *T. solium* in two cases. According to Mangold, 128 tapeworm patients were treated in Tübingen between the beginning of 1885 and the end of 1894; of this number, 120 were infested with *T. saginata*, six with *T. solium* and two with *Bothriocephalus latus*. In this connection it is worthy of note that all six cases of *T. solium* occurred in the first year of the report. This condition agrees with that which has been found by statistical investigation in Vienna, Holstein and Italy.

Since the 60's, Krabbe identified 400 tapeworms which were sent to him from various parts of Denmark. His studies yielded the following instructive results:

Year.	T. Saginata.	T. Solium.	T. Cucumerina.	Bothriocephalus latus.
Before 1869	37	53	1	9
1869–1880	67	19	4	11
1880–1887	86	5	4	5
1887–1895	89	—	6	5
Total	279	77	15	30

According to Bérenger and Férand, the number of tæniæ found in France in the marine hospitals increased from 0.2 per cent. in 1865 to 14.5 in 1890; in the city hospitals, from 2.6 per cent. in 1866 to 6.14 per cent. in 1890. Simultaneously *T. saginata* became very frequent, while *T. solium*, on the other hand, became unusually rare. Of the 191 tapeworm cures concerning which Bérenger and

Férand reported, 112 whole tæniæ with the head were passed. In all 112 cases the species was *T. saginata.*

In the United States, Stiles made a study of 297 tapeworms, which, without exception, proved to be specimens of *T. saginata.* Herff, on the basis of forty years' practice, reports that *T. saginata* is very common in Texas.

This striking disproportion between the appearance of *T. saginata* and the measle worms in cattle was explained by the discovery which was made by municipal meat inspection in Berlin. At the suggestion of Hertwig, late director of Berlin meat inspection, after a number of occasional discoveries of measle worms in the masticating muscles, it was ordered that in all cattle which were submitted for inspection the masticatory muscles should be examined by means of an incision. From this order the surprising result was obtained that, in sharp contrast to the first five years (1883 to 1888), in which only four cases of beef measle worm were demonstrated, several hundred cases were found in a single year. This frequent finding of cysticerci could not be explained by assuming that the bladder worms were suddenly becoming more common among cattle. They had been formerly overlooked, for the reason, as appeared later, that cattle are only rarely so strongly infested that the worms appear on the surface of the muscles during the ordinary inspection at the time of slaughter. It frequently occurred that beef measle worms were found only in the muscles of mastication, while no other examples could be found, as a rule, in all of the musculature, even by a most careful inspection. The result of investigations in later years corresponds completely to that of the first year and justifies the assumption that the muscles of mastication are to be considered as the most usual location of beef measle worms.

It is a remarkable fact that more male than female cattle are found to be measly. In Neisse, for example, the ratio of male measly cattle to female was 8 : 5, although in that locality more cows and calves were slaughtered than bulls and oxen. This peculiar condition may be explained in the first place by the fact that the majority of male cattle are slaughtered at a young age, in which the infestation from larval tapeworms usually occurs, and also by the fact that the beef measle worms, after having infested an animal may later become entirely disintegrated (The Author).

Reissmann compiled the following interesting table concerning the relationship of sex and infestation by cysticerci in Berlin. The following numbers of animals were found measly:

Year.	Bulls.		Steers.		Cows.	
	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
1892–93.	101	.118	86	.147	38	.124
1895–96, ...	110	.227	113	.209	47	.156
1899, ...	354	.554	103	.548	86	.309

Usual Location and Frequency.—In by far the greater number of cases, cattle show only a slight invasion, with the seat of the parasite in the masticatory muscles and heart. Thus, in Berlin beef muscle worms were found distributed in the following locations during the different years of the report, 1888–1890 :

1. In the masticatory muscles..... 316
2. In the masticatory muscles and heart..... 39
3. In the masticatory muscles and cervical muscles..... 1
4. In the masticatory muscles and the tongue..... 4
5. In the cervical muscles..... 1
6. In the cervical muscles and tongue..... 1
7. In the tongue..... 2
8. In the tongue and heart..... 2
9. In the thoracic muscles and tongue..... 1
10. In the whole musculature..... 22

According to these figures the cysticerci, except in twenty-two cases in which they were distributed throughout the body, were located :

1. In the masticatory muscles..... 360
2. In the heart..... 41
3. In the tongue..... 10
4. In the cervical muscles..... 3
5. In the thoracic muscles..... 1

In later years the same condition prevailed. In the year 1899, for example, of 785 measly cattle, 754 showed only 1 cysticercus, and in 767 cases the larval tapeworms were found only in the masticatory muscles (in 266 animals, only in the internal ; in 488, only in the external, and in 13, in both the internal and external masticatory muscles) ; 14 times in the heart ; 9 times in the masticatory muscles and the heart ; once in the heart and in the tongue ; 3 times in the masticatory muscles and tongue ; once in the masticatory muscles, heart and thoracic muscles ; once in the masticatory muscles, heart, and diaphragm ; once in the heart, shoulder and thoracic muscles ;

and in the remaining cases generally distributed throughout the muscles.

Furthermore, in other German abattoirs, as in foreign countries, with the regular inspection of the masticatory muscles, only occasionally are cysticerci found in cattle. The proportion of measly cattle in the kingdoms of Prussia and Saxony, in which cattle are regularly inspected for cysticerci in the abattoirs, averages about $\frac{1}{2}$ per cent., ranging from .16 per cent. to 4 per cent.*

From the account already presented concerning the distribution of beef measle worms in individual cases, it is apparent that next to the masticatory muscles, but much more rarely than these, the heart was infested by the larval tapeworms. This fact was established in Switzerland before it was discovered in Berlin. Zschokke asserts that in the Canton of Zurich 19 cases of measle worm in cattle and 38 in calves were observed in 1886 as a result of careful inspection of the heart. Melchers reported also from Neisse that he found as many cases of infestation by measle worms in the heart as in the head or masticatory muscles.

At first, chief attention was directed to the finding of beef measle worms in the internal masticatory muscles. Glage, however,

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* The number of cases of infestation from cysticerci in cattle has increased from year to year in consequence of the more generally applied inspection for these larval tapeworms. The number of cases in the public abattoirs of the Kingdom of Prussia amounted to 567 in 1892, 1,143 in 1895, 5,471 (.5 per cent.) in 1899; and in the Kingdom of Saxony, 47 in 1893, 227 in 1895 and 496 (.46 per cent.) in 1899.

Cysticerci are most frequently found in the abattoirs at Neisse, Danzig, Madgeburg, Eisenach, Aachen, Marienwerder and Kiel. The following numbers were found in :

Neisse	1891–1896	3.2 –4.	per cent.
Danzig	1894–1900	.36 –3.76	"
Madgeburg	1893–1899	.26 –1.319	"
Eisenach	1893–1894	1.91	"
Aachen	1895–1898	.17 –1.24	"
Marienwerder	1893–1895	.34 –1.02	"
Kiel	1891–1899	.21 – .8	"
Dresden	1898	.477	"
Berlin	1892–1899	.16 – .47	"
Königsberg in Prussia	1899	.477	"
Leipsic	1890–1900	– .32	"
Oppeln	1894	.23	"

Concerning beef cysticerci in foreign countries, reports have been made by Krabbe in Copenhagen, Morot in Troyes, Messner in Carlsbad, Mautner in Ischl, Muny in Fuime, and several Italian authors. According to Krabbe, 133 or 0.044 per cent. of the 30,000 cattle which were slaughtered in the abattoir at Copenhagen in 1894, were found to be measly.

showed that the external masticatory muscles are infested with equal frequency and even when the measle worms were not found in the internal masticatory muscles.

In addition to the masticatory muscles and the heart, the tongue, cervical muscles, muscular portion of the diaphragm and intercostal and thoracic muscles must be considered as favorite locations for the beef measle worm. According to Noack, these parasites are frequently encountered in cutting up measly beef animals, in the muscle group known as the round and rump.

With the exception of the heart, the vital organs of cattle are not usually infested with cysticerci. Only in cases of extensive invasions are the lymph glands, lungs, liver and brain infested. Exceptionally, however, in cases of quite slight invasions, cysticerci are found in the lymph glands, lungs, liver, brain and esophagus.

In an African beef animal, Morot found the internal masticatory muscles less strongly infested with cysticerci than the tongue and heart. The animal in question was extensively infested. In addition to the tongue and heart, cysticerci were found in large numbers in the muscles of the shoulder, foreleg and also in those of the back, rump and hind quarter.

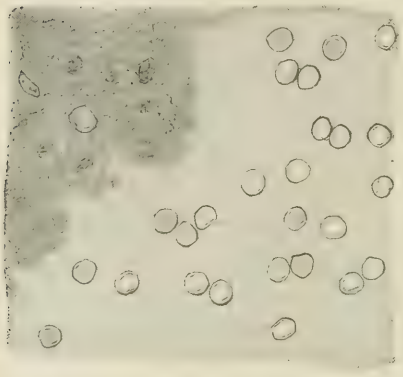
Diagnosis. — The recognition of fully-developed, uninjured cysticerci is not difficult. It is only on the surface of the body that they easily escape notice in consequence of desiccation (Laboulbène). In other cases, the thin wall and the cyst with the invaginated scolex, which, however, may be easily protruded by pressure between the two fingers, constitutes unmistakable evidence of cysticerci. We have also the characteristic corrugation of the caudal cyst, the neck permeated with calcareous corpuscles, and, finally, the head armed with four sucking disks, but without hooks. These characters make certain the identification of the cysticercus of *Tænia saginata*, when examined under the microscope.

Under certain conditions, the positive demonstration of undeveloped or degenerated cysticerci may be more difficult; in the first case, when the differentiation into scolex and caudal cyst has not yet taken place, and in the latter case, when total calcification has obliterated all normal structure of the parasites. In the first case, however, the peculiar pear shape or round form of the immature cysticerci, surrounded by newly-formed connective tissue, and the bloody exudate (Figs. 126, 127) render a provisional diagnosis possible. In the latter case, as shown by the author, the demon-

stration of calcareous corpuscles is decisive.* For the demonstration of these diagnostically important characters, it is sufficient to examine an ordinary teased preparation under slight magnification.

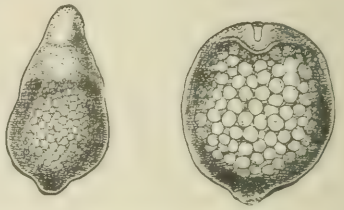
For the detection of isolated cysticerci, it is absolutely necessary to examine carefully in every beef animal the masticatory muscles and the heart.†

Fig. 125



Calcareous corpuscles from a teased preparation of a casefied bladder worm. × 150 times. Caseous detritus above to the left.

Fig. 126. Fig. 127.



Beef bladder worms in development.

In the demonstration of cysticerci in sausages, Schmidt-Mülheim proposed the following method, which is based on the resistance of the scolex to the digesting power of the gastric juice:

A small sample of sausage or minced meat is digested for several hours continuously at a temperature of 40° C. and with repeated stirring in six to eight times its volume of artificial gastric juice, which is easily obtained by extraction of the minced mucous membrane of a hog's stomach with 0.5 per cent. hydrochloric acid.

* Under the term calcareous corpuscles are understood the delicate, glassy, transparent disks which occur by thousands in the neck of the cysticerci. They are round, oval, reniform or sausage-shaped. The majority of them, however, possess a round or oval form (Fig. 125). The calcareous corpuscles vary in size between 0.0015 and .019 mm. and consist of albuminate of lime. After the addition of dilute acids there is a residue which shows the original form of the calcareous corpuscles.

† Formerly in southern Germany, the requirement of an inspection for beef measles was omitted and partly for the curious alleged reason that it was superfluous, since the meat was eaten in a cooked condition. The fallacy of this reasoning is shown by statistics collected by Mangold from clinics in the University of Tübingen, in which, during a comparatively short period, 120 persons were treated for *Tænia saginata* infestation.

While the meat and fat are digested and the latter collects in the form of a more or less considerable layer of fat on the surface of the fluid, only the wall of the cyst of the cysticerci which may be present is attacked and the scoleces (and especially the circle of hooks in the hog measle worm) exhibit an extraordinary resistance to the action of the gastric juice. Since these possess also a rather high specific gravity, they collect at the bottom of the vessel and may be at once recognized in this situation as white bodies of the size of rice grains. Upon closer examination, especially in water, it is found that the white bodies, in which, even after exposure to the gastric juice for a day, only traces of an incipient solution are apparent, exhibit strongly marked transverse folds and that the completely intact head of the cysticercus is withdrawn into the hollow cephalic prolongation or is protruded. In both cases the head is easily isolated by means of dissecting needles. The sucking disks and, in the case of hog measle worm, the circle of hooks, then become apparent under a magnification of 20 diameters after clarifying the preparation in dilute glycerine.

FIG. 128.

Bladder worm calcified at a young stage, with strongly developed connective tissue capsule. × 35 diam.

Rissling proposed a simpler method of demonstrating cysticerci in sausage. This is based on the different specific gravity of the scoleces of the cysticerci and the muscle fibers and is practically as follows:

A lye is prepared from caustic soda, potash, or some other readily-soluble alkali, in such concentration that pieces of meat which are poor in fat readily float on the surface. After it is clarified as much as possible, the lye is poured into a sufficiently broad glass vessel containing from one to four liters and the vessel drawn out to a point at the lower end. The finely minced meat or sausage to be examined is mixed with a small quantity of lye, and, without being crushed, is stirred so as to form a uniformly thin broth and is then added to the lye. Water is added, while the lye is being con-

stantly stirred, until some of the pieces of meat begin to sink. If cysticerci are present, they immediately sink to the bottom and are then easily isolated by pouring off the rest of the material.

In order to test the viability of the cysticerci, we may use the method of warming (Leuckart and Perroncito). Living cysticerci when heated to a temperature of 30 to 40° C. exhibit under the microscope active movements of the rostellum, sucking disks and other parts of the head and neck; while killed or dead cysticerci remain motionless. This thermo-microscopic investigation may be undertaken conveniently in the Nuttal microscope thermostat as well as in the simpler and cheaper warming apparatus for microscopic investigation devised by Kabitz and Rissling (*Zeit. f. Fleisch. u. Milchyg., VI*).

Differential Diagnosis.—The beef measle worm may be confused with the larval form of *Tænia marginata* (*Cysticercus tenuicollis*) and with echinococci.

Cysticercus tenuicollis is not found in the striated musculature, but only under the serous membranes and, in young animals, also in the liver. Furthermore, it possesses a double circle of characteristically-formed hooks (page 397).

Echinococci, which occasionally occur also in the musculature, are distinguished from cysticerci by their round form and by the absence of any structure corresponding in size and form to the scolex of cysticerci. The echinococcus is either sterile—that is, without any head-like structure—or fertile—that is, furnished with numerous brood capsules. Furthermore, the lamellate structure of the cuticula of echinococci furnishes a good differential diagnostic character (page 512). As a rule, the lamellate structure is also apparent in degenerated echinococci and furnishes, therefore, in such cases, a certain criterion for diagnosis.

Kieckhäfer described a case of lymph cysts resembling cysticerci which had given occasion to confusion with beef measle worms. The cysts, the nature of which was immediately apparent upon incision, were located on the hyoglossus muscle and varied in size from that of peas to hazel nuts.

Judgment.—A tapeworm (*Tænia saginata*) develops in the alimentary canal of man from the beef measle worm. This tapeworm may affect the health of the host by causing distress, by withdrawing nutriment and frequently by recurrent digestive

disturbances. Measly beef may, therefore, be considered a dangerous food material. In this connection it should be remembered that *Tænia saginata*, which develops from the beef measle worm, is difficult to expel. On the other hand, the beef measle worm is not so dangerous to human health as the hog measle worm, since, according to all reliable observations, autoinvasion—that is, the formation of cysticerci in the vital organs of the host of *Tænia saginata*—does not occur in cases of infestation by this parasite. In general, the cysticercus disease, as rightly asserted by Bollinger, cannot be considered in the same class with other zoonoses (anthrax, glanders, intestinal sepsis, trichinosis), since the tapeworm disease which arises from eating measly beef is not actually dangerous to life and often causes only very slight disturbances, and, as compared with the echinococcus disease, is to be characterized as almost harmless.

Measly beef is dangerous only in a raw or half-cooked condition. This is shown by the fact that cooks and servant girls who commonly sample the meat during its cooking, furnish a large contingent to the hosts of *Tænia saginata*.* By means of a suitable treatment of measly meat, we are in a position to kill the cysticercus and render harmless the infesting parasites.

Judgment of Immature and Degenerated Cysticerci.—It must be considered as certain that cysticerci are incapable of developing into tape worms in the intestines of man before they have reached a certain developmental stage. This power is wanting, at least in cases where the head is absent or just beginning to develop, as well as in cases of incomplete development of the suckers. Similarly, completely degenerated cysticerci, in which the parasite itself appears to be cloudy or already calcified, must be regarded as harmless. Meat infested with such cysticerci may, therefore, be admitted to the market as harmless food material, without any special treatment, if it appears certain from an examination that only undeveloped or degenerated cysticerci are present.

In the previous discussion, however, attention has already been called to the fact that along with degenerated cysticerci intact individuals may also occur, and this is frequently the case in cattle.

* The connection between the frequent occurrence of tapeworms and the custom of eating raw meat appears very plainly also from the statistics of army physicians. According to these statistics there is in no one of the German army corps so high a percentage of tapeworm infestations as in the Tenth, which is recruited chiefly from lower Saxony, where the consumption of raw minced meat is widely prevalent

The occurrence of intact cysticerci in the muscles of mastication at the same time that degenerated individuals are found in the heart is especially frequent. For, in the latter organ, the cysticerci may degenerate even during development. The simultaneous occurrence of intact and degenerated cysticerci in the other muscles is rarer. In cases where the degenerated cysticerci are found, a careful examination of the favorite locations of the parasites should be undertaken in order to determine whether living specimens are found with the degenerated individuals. In an examination which I made at the Berlin abattoir, I found that when the muscles of mastication contained only degenerated cysticerci, the other musculature contained no living parasites.

Method of Destroying Cysticerci.—Beef measle worms may be killed by heating and by laying in brine. Moreover, it has been demonstrated that these parasites naturally disintegrate at the latest within three weeks after the death of the host. Finally, a destruction of the cysticerci may be brought about by freezing.

1. Killing by Heat.—Perroncito observed that a temperature of 45° C. was sufficient to kill beef measle worms, as evidenced by the fact of their cloudy appearance, their non-motility when examined under the microscope, and the negative results from transmission experiments. Hertwig found in cysticerci which had been exposed to a temperature of 65° C. that the scolex, which in a living condition was unusually resistant to pressure, was so soft that it could be compressed between slides, like beef tallow. This alteration must be considered as an excellent criterion of the accomplished destruction of cysticerci by boiling. By means of the above demonstration, Hertwig simultaneously disproved the widespread erroneous view that cysticerci which had been killed by boiling or roasting could be detected in eating the meat by a crackling sound between the teeth. In masticating boiled or roasted meat, one can not detect any cysticerci which may be present.

Measly beef may thus be rendered harmless by boiling. It should be observed that meat is a poor conductor of heat and that a high degree of heat is attained in the interior of the pieces only slowly. This question will be considered more in detail in the special chapter on the "Boiling of Meat, etc." In this connection it may simply be mentioned that, according to experiments thus far made, the certain destruction of all cysticerci present in meat may be assumed if the meat, in pieces of any convenient length, but not

too thick (up to 12 cm. in thickness), has been boiled for two hours. The meat is then well done and on cross section appears to be of a uniform gray color. Since this alteration of color does not occur until a temperature of 60° to 70° C. is reached (page 202), or a temperature which is more than sufficient to destroy the beef measle worm, we possess in this change a very efficient method for determining whether a sufficiently high temperature has been produced uniformly throughout the meat for the destruction of the cysticerci.

Measly beef which after boiling exhibits a gray color on cross section may thus with certainty be characterized as a harmless food material.

Against compulsory boiling of measly beef before sale there is the one objection that a considerable depreciation of value is necessarily connected with the process. By the process of boiling, the meat loses as much as 50 per cent. in weight, and purchasers of boiled beef, even at low prices, are difficult to find.

2. Killing Cysticerci by Pickling.—Likewise, concerning the destruction of cysticerci by pickling, we owe the first experiments to the noted Italian investigator, Perroncito. This author demonstrated that isolated cysticerci are killed within twenty-four hours in a solution of common salt. But little use, however, is made of pickling for rendering measly meat harmless, since detailed information concerning the penetration of salt solutions into the interior of the pieces of meat is wanting. The author, therefore, tested this question by treating measly meat with salt solutions and examining the cysticerci contained in the meat, after the lapse of fourteen days, by heating in Nuttal's microscope-thermostat. The brine used in these experiments was of the same composition as that used by butchers in the ordinary commercial preservation of meat. It consisted of 2½ parts saltpetre, 20 parts cane sugar, 250 parts common salt, and 1000 parts water. The brine solution, therefore, contained 25 per cent of common salt.

The experiments showed that cysticerci contained in measly beef and pork invariably died within fourteen days, provided the meat was laid in the brine in pieces not too thick (up to 6 cm. in thickness), or provided that the brine was injected into the pieces of meat by means of a brine syringe, in accordance with the suggestion of Glage.

The destruction of the cysticerci keeps pace with the degree of pickling. For demonstrating the completion of the process of pick-

ling, we possess a simple means in a 1 per cent. solution of nitrate of silver (the author). The solution of nitrate of silver produces no striking change on the cut surface of fresh muscle meat, but, on the cut surfaces of completely pickled meat, a temporary milky cloudiness is produced (chloride of silver). For making this test, one carefully washes in water the pieces of meat to be examined, dries the surface with a cloth, and makes a rapid cut through the middle of the piece of meat. The cut surface is then held upward and a few drops of a solution of nitrate of silver are allowed to fall on the middle of the section. In order to proceed with certainty, the solution of nitrate of silver may be poured into a funnel-shaped cavity which may easily be produced in the middle of the cut surface of the meat by cutting out (with a knife) a conical piece of meat. Glage has proposed a more accurate process for the demonstration of the completion of the pickling process. He employs a 2 per cent. aqueous solution of nitrate of silver which is rendered non-sensitive toward small quantities of salt by the addition of ammonia. The preparation of Glage's reagent for the demonstration of pickling takes place according to the following recipe :

℞

Argent. nitric. 2
Aqu. dest. 100
Mf. Sol.

Adde exactissime Liquor. Ammon. caust. q. s. ad præcip. et perfect. resolut. Argenti; deinde Liquor. Ammon. caust. volumetr. 40 cc. Aqu. dest. q. s. ad 200 cc. in vitro flavo.

On account of the excess of 40 cc. of normal ammonia, the mixture is so desensitized as a reagent for chlorine that in 10 cc. of the mixture—and not less should be used for each test—a precipitate of chloride of silver does not occur until after the addition of 2.7 cc. of a 1:100 normal salt solution, while smaller quantities do not alter the clear reagent or merely produce a precipitation of chloride of silver which is immediately redissolved. In the use of Glage's reagent, there is no precipitation of the chlorides which normally occur in the body and which in the use of the simple solution of silver nitrate may interfere to a considerable extent, especially in the differentiation of fresh and salted livers. For carrying out the test, one should pour 10 cc. of the reagent into a glass vessel furnished with a polished glass stopper and without any neck-like constriction and should then drop into the reagent one gram of the meat to be examined, taken from the inside of a piece. If, after vigorous shaking, a white precipitate is formed

which becomes violet or blackish in sunlight, the meat is to be considered as salted throughout.

The pickling of measly beef, as compared with compulsory boiling, possesses the advantage that the meat by the former process loses only about 6.5 per cent. in weight, and is much more easily sold than boiled meat (Rieck).

3. Natural Death of Beef Measle Worms During Long Preservation of the Meat.—It was likewise Perroncito who observed that cysticerci die within a certain time after the death of the host. He found in a calf which had been artificially infested with cysticerci that all the parasites were dead 14 days after the slaughter of the animal. The tests instituted by the author showed that natural death does not uniformly occur in the above-named period, but that by preserving measly beef for three weeks the cysticerci contained in it are rendered harmless.

The demonstration of the fact that the cysticerci in meat preserved for three weeks were dead was confirmed not only by the application of heat, but, in order to remove all doubt, by digestion experiments and especially by infection experiments in which, beside the author, a large number of students and assistants at the Veterinary High School at Berlin took part. The results thus obtained have been confirmed by the autoinfection experiments of the chief city veterinarian, Reissmann, in Berlin, and several other city veterinarians in that place, as well as by the Dresden abattoir veterinarian, Zschokke.

Rendering measly beef harmless by preservation of the meat for three weeks, which, in order to avoid decomposition, should take place in cold storage, is the most rational method, since the meat thereby undergoes the least depreciation in value. It suffers only a minimum loss of weight and finds ready sale as raw meat.

4. Killing Cysticerci by Freezing.—It has been demonstrated by Rissling, Glage and Reissmann, that beef and hog measle worms are killed by freezing. Glage determined that in measly pork which was preserved for fourteen days at a temperature of — 10° to — 15° C., all the cysticerci die. According to Reissmann, this result takes place in fairly large pieces of beef and in larger than medium-sized hams after the lapse of four days, provided that the pieces of meat are kept at a temperature of — 8° to — 10° C. Cysticerci killed by freezing exhibit, in addition to their lack of motility

in the thermostat, a peculiar sticky character (Glage); also a dissociation of the calcareous corpuscles and a total stainability.

Freezing, therefore, is a practical method for rendering measly beef harmless. It has the one disadvantage that the keeping quality of the meat is considerably affected by the process of freezing. Frozen meat rapidly decomposes and must, therefore, be quickly utilized.

Other Methods of Killing Cysticerci.—For the sake of completeness, it may be mentioned that cysticerci may be killed also by acids and by the action of electric currents (Glage). The practical application of these methods, however, meets with difficulty. In the acid method, the superficial layers of the muscles are changed into gray flaky masses and the deeper-lying portions are not easily penetrated by the acid. Difficulties were met with in the application of the electric current from the lack of uniformity in the development of heat at the different poles. It sometimes happened that the meat was burned and the fat melted. Moreover, in the use of the method characterized by Glage as "electrical sterilization in a raw condition," the meat was rendered somewhat soft by the separation of a portion of its albumen, a fact which interfered with its continued preservation.

Cysticerci are not injured by decomposition. The author, in harmony with Reissmann, found that cysticerci may remain alive even in badly decomposed meat.

Method of Procedure with the Meat of Measly Cattle.—Measly beef may be allowed on the market, provided the cysticerci have been killed by one of the above mentioned methods, or provided the sale of the meat takes place under such precautionary measures as to permit the assumption that it will be eaten only in a harmless condition.

In localities in which the sale of meat is under police supervision, measly beef may, therefore, be sold in a raw condition if accompanied by a statement of its peculiar character and with explicit directions that it must be cooked before it is eaten. (See decisions of the Imperial Court, page 117, especially Decision IV. of July 11, 1884, and September 29, 1885). Measly beef is sold under these conditions in southern Germany. If, however, the above mentioned proviso is not realized, measly beef should be admitted to the market only after having been rendered harmless.

Measly meat, even after the destruction of the cysticerci by boiling, pickling, or preservation of the meat for three weeks, is to be considered a spoiled (inferior) food material, and is, therefore, to be sold only when a statement is made of its peculiar character. Measly meat must be absolutely excluded from the market even in a cooked condition if the cysticerci are distributed in large quantities throughout the whole musculature, or if the meat has assumed a watery character in consequence of the invasion of cysticerci.

As already indicated, there is no reason for excluding from the market viscera which are free from cysticerci, for they show no variation whatever from the normal. Fat tissue which is free from cysticerci is to be judged similarly.

Regulations Concerning the Method of Procedure with the Meat of Measly Cattle.*

In the Kingdom of Prussia the method of procedure with the meat of measly cattle is regulated at present by a ministerial decree of November 18, 1897, concerning the sanitary police procedure with measly cattle and calves. The decree reads as follows:

By a circular decree of February 16, 1876, the regulations which seem to be required in the interest of sanitary science for the treatment of measly hogs, according to the opinion of the Royal Scientific Deputation for the Medical Service of February 2, 1876, are made known, and are also applicable in the case of measly cattle.

Since the conditions for the destruction of the beef measle worm have been more accurately determined by detailed investigations, we have compiled "the principles for the sanitary police procedure with measly cattle and calves." While we hereby repeal all previous regulations and order that until further notice procedure in this case shall be governed according to the principles hereby formulated, we call attention at the same time to the following statements:

For the purpose of bringing about a uniform practice of inspection for beef measle worms, the examination should be made in such a manner that the musculature which is exposed during slaughter, especially the external and internal muscles of mastication, tongue and heart, should be carefully inspected, and that extensive incisions parallel with the rami of the maxillary bones should be made in the muscles of mastication.† Meat is to be considered well boiled when a uniform gray color is observed on a fresh cross section.

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* From the time when the Imperial Meat Inspection Law comes into force, regulations of general application will exist concerning the method of procedure with the meat of measly cattle.

† In calves up to the age of six weeks, the inspection of the muscles of mastication for cysticerci may be omitted. (Circular decree of the Ministries of Agriculture, etc., July 1, 1898).

The content of salt solution is to be accurately determined or controlled in the preparation of brine, or by means of the alkalimeter.

The pieces to be utilized in pickling shall not be heavier than 2½ kg. Pickled meat is to be kept under police control during the prescribed period.

For the determination of the temperature in cold storage rooms, tested maximum and minimum thermometers are to be used, and reliable self-registering hygrometers for the determination of the moisture.

The temperature and moisture content of the room are to be taken during the forenoon and evening of each day and to be registered in tabular form.

When properly equipped, cold storage rooms in operation in public abattoirs can be considered as "suitable." The district veterinarian, in coöperation with the local police authorities, shall decide in each individual case whether the conditions for the proper treatment of the meat by cooking or hanging are present. The meat of cattle which are only slightly infested with cysticerci may be hung in quarters in special apartments under police control; that of calves in a similar condition, without quartering. In a given apartment, only the meat of one or several measly animals slaughtered on the same day should be hung; the dressed meat of animals slaughtered on different days should be placed in the same apartment only when the pieces of meat are so stamped that all possible confusion is avoided.

Although it has been demonstrated by previous investigations that the decomposition of the meat does not take place in cold storage rooms with the required temperature and moisture content, it should, nevertheless, be determined by a veterinarian after the lapse of 21 days and before the meat is discharged, whether the meat has kept well and is not spoiled.

By means of the provision that the meat of animals slightly infested with cysticerci and which has been rendered suitable for human consumption shall be sold only to the consumer or for domestic use, it is intended to prevent commercial middlemen, butchers, sausage makers, and hotel keepers from obtaining possession of such meat. If considered necessary, the resale of this meat is to be forbidden under penalty of law.

A report is to be made on measly cattle and calves according to the enclosed scheme covering the preceding calendar year up to February 15 of each year, and, beginning with February 15, 1899, is to be concluded by a short report on the operation of these regulations.

Finally, for the purpose of communicating with the districts concerned, we give notice that the opinions of the Scientific Deputation for the Medical Service and of the Technical Deputation for the Veterinary Service, which furnished the foundations for the decree of these regulations, are published in the Vierteljahrschrift für Gerichtliche Medizin und Oeffentliches Sanitätswesen, XIV., Supplement, October, 1897, pp. 117, 142.

Principles Governing the Sanitary Police Procedure With Measly Cattle and Calves.

According to the number of cysticerci, distinction is made between

(*a*) Animals with at most ten living cysticerci: *slightly infested animals.**

(*b*) Animals with more than ten living cysticerci: *badly infested animals.*

* By means of a circular decree of the above mentioned Ministries of June 16, 1898, it is ordered that in estimating the number of cysticerci, all living cysticerci shall be included which are found before boiling, pickling, or hanging the meat in cold storage, without regard to the place or time, or whether they are found during slaughter or during the subsequent cutting up of the meat.

I.

For free utilization as human food are admitted:

1. Rendered lard, unconditionally.

2. The liver, spleen, kidneys, stomach and intestines of animals slightly infested with cysticerci (*a*) in so far as these organs are found upon veterinary inspection to be free from cysticerci.

3. Animals slightly infested with cysticerci (*a*) in which the cysticerci which are found are, according to veterinary opinion, in a condition of complete calcification.

II.

For domestic use or for sale in special booths, freibanks, etc., in pieces not larger than 2½ kg. and for sale only to the consumers and under statement of its measly nature, it is permitted to sell meat of animals slightly infested with cysticerci (*a*) after its dangerous properties have been removed under veterinary supervision:

1. By thorough boiling.

2. By pickling for twenty-one days in a 25 per cent. brine, or,

3. By preservation for twenty-one days in suitable* cold storage rooms in which a temperature of 3 deg. to at most 7 deg. C. prevails and a moisture content of 70 to at most 75 per cent.

III.

The carcasses of animals badly infested with cysticerci (*b*) are to be utilized for technical purposes or otherwise rendered innocuous under police supervision.

In the Kingdom of Saxony, the meat of measly cattle, according to Section 5 of the new regulations, Appendix 6 to Section 16 of the regulations for carrying out the Saxon Meat Inspection Law (principles underlying the judgment of meat), is to be thoroughly boiled, pickled or refrigerated.

In the Grand Duchy of Baden, the following principles prevail:

1. Meat is to be considered as unfit for food when the cysticerci are present in such numbers that they are seen on the majority of the cut surfaces in the body musculature.

2. The meat of animals slightly infested with cysticerci—that is, animals in which only isolated cysticerci occur, except in the muscles of mastication—is to be considered as fit for food, but not marketable after a previous boiling, pickling or refrigeration for three weeks under police supervision. The temperature in cold storage must not exceed 5 deg. C. If the cysticerci are shown to be dead, this procedure is not necessary.

3. The meat of animals in which only isolated cysticerci occur in the muscles of mastication is marketable, but in such cases the head is to be treated according to N. 2.

In other States the present procedure with measly beef will remain the same as that with measly pork until the regulations for carrying out the Imperial Meat Inspection Law bring out uniformity in this matter.

Judgment of the Viscera of the Meat of Measly Cattle.—As a rule, the viscera of measly cattle, with the exception of the heart,

* The District Veterinarian, in connection with the local authorities, shall decide concerning the "suitability."

contain no cysticerci. The viscera can not, therefore, be regarded as dangerous to life, like musculature infested with the parasites; and, if they are shown to be free from cysticerci by inspection, they require no treatment for rendering them harmless, but in such cases may be freely admitted to the market.

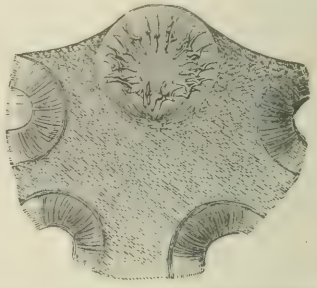
(b) Hog Bladder Worm (Cysticercus Cellulosæ).

Nature.—The hog measle worm is the larval stage of a thin tænia of man, erroneously considered a solitary tapeworm (*Tænia solium*, Rudolphi). *T. solium* is 2 to 3 m. long; the mature pro-

Fig. 129.

Scolex of Cysticercus cellulosæ.
× 12 diameters.

Fig. 130.



Circle of hooks of the pork bladder worm. From a photograph.
× 35 diameters.

glottides are provided with a uterus which sends out from seven to ten lateral branches on either side. On account of its location in the connective tissue which lies between the muscle fibers, the hog measle worm is given the name "connective tissue bladder worm" (*Cysticercus cellulosæ*). *C. cellulosæ* is provided with a double row of hooks (Fig. 130).

Historical.—According to Falck, the hog bladder worms were described by Aristotle. Moreover, they were mentioned in the

earliest regulations concerning meat inspection, and the frequency of their occurrence led to the establishment of special sale booths, "measle banks" or freibanks. According to Braun, it was demonstrated by the experiments of Küchenmeister (1855), Humbert (1854), Leuckart (1856), Hollenbach (1859) and Heller (1876) that *Cysticercus cellulosæ* develops into *Tænia solium* in the human intestines. Similarly, by feeding ripe proglottides to hogs, *Cysticercus cellulosæ* was repeatedly reproduced (Van Beneden, 1853; Haubner and Küchenmeister, 1855; Leuckart, 1856; Mosler, 1865; Gerlach, 1870, *et al.*).

Morphology.—With regard to its location between the muscle fibers and also in great degree with respect to its microscopic peculiarities, *Cysticercus cellulosæ* agrees with the beef measle worm. For the rest, the hog bladder worm shows the following peculiarities: The cyst is more delicate and therefore more transparent than in the case of beef measle worm. The scolex, when invaginated into the caudal bladder, therefore, shows through the cyst more conspicuously in the case of the hog measle worm than in the beef measle worm. Moreover, the scolex of the hog measle worm possesses a double circle of hooks which is wanting in the beef measle worm. The number of hooks amounts to 22 to 28 (Fig. 130). The hooks are of compressed form with strong bases and rather slightly curved points (Fig. 134). The length of the large hooks is 0.16 to 0.18 mm.; that of the small hooks, 0.11 to 0.14 mm.

The size of the hog measle worm varies, as in the case of the beef measle worm, according to the stage of development in which the parasites are found at the time of the slaughter of their host. By means of feeding experiments, Gerlach demonstrated the following facts concerning the development of the hog measle worm:

1. Cysticerci 20 days old: A delicate transparent vesicle of the size of a pin head without enveloping membrane; rudimentary head indicated by a cloudy point.

2. Cysticerci 40 days old: Enveloping membrane still very delicate; of the size of a mustard seed or sometimes larger; head very plain; sucking disks and a circle of hooks recognizable, but not completely developed.

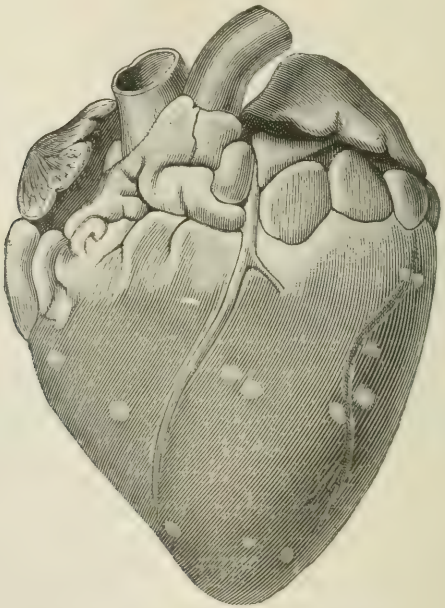
3. Cysticerci 60 days old: While in the enveloping membrane, of the size of a pea or larger; when taken out of the connective tissue enveloping membrane, more reniform; head projecting somewhat from the vesicle as a faint white button-like structure; true

neck still wanting; row of hooks and sucking disks completely developed; difference in size.

4. Cysticerci 110 days old: All of about the same size; neck developed; transverse furrows indicated; the head, free from the firm enveloping membrane, lies invaginated into the caudal cyst. After the head is forced out, the cysticerci have the form of a flask.

Occurrence.—In contrast with the distribution of *Cysticercus bovis, C. cellulosæ* is comparatively rare in our native hogs. In some

Fig. 131.



Heart of a hog infected with Cysticercus cellulosæ.

parts of Germany, as Bavaria, Würtemburg, Baden, and Hohenzollern, the hog measle worm is almost never observed at present. This rare occurrence of the hog measle worm corresponds with that of *Tænia solium* in man.* Formerly the hog measle worm was of quite frequent occurrence, even among the native hogs. At present only hogs imported from Russian Poland, Galicia, Bohemia, Servia and Roumania are found to be frequently infested with cysticerci. Among Servian hogs, the introduction of which into

* According to Mangold, the last cases of *T. solium* at the Tübingen Medical Clinic were observed in 1887.

Germany was quite extensive up to the beginning of the 90's, one-half of the shipments were frequently found to be measly.

The gradual disappearance of the hog measle worm from Germany is a classical demonstration of the certain and beneficial effect of a regulated meat inspection. In this respect there is no essential difference between northern and southern Germany. While in northern Germany meat inspection has only recently been subject to general regulations, the extermination of hog measle worms was begun long ago, for trichina inspectors were instructed to take notice of the presence of cysticerci when taking samples for trichina inspection. At present it is only in the eastern provinces of Prussia that cysticerci in hogs are demonstrated with comparative frequency.

It is worthy of mention that, according to the results of Gerlach's feeding experiments, the eggs of *Tænia solium* are unable to develop into cysticerci except in young swine (pigs up to one-half year old).

Frequency of Cysticerci in Hogs.—Concerning the frequency of cysticerci in native hogs, the following figures are available:

In the Kingdom of Prussia, according to the seven-year average (1876-1882), one in every 305 hogs slaughtered was measly (Johne). Later the proportion became constantly wider. From 1886 to 1889, it was 1 in 551; in 1890-1892, 1 in 817; and, finally, in 1896, 2 in 1,470.

In the Kingdom of Saxony, in 1894, one in every 686 hogs was found to be measly. In 1895, the proportion widened to 1 in 2,049, and in 1896, 1 in 5,886.

In Berlin, in 1883-1884, 1,621 measly hogs were found among 244,343; in 1884-1885, 1,468 in 264,727; in 1885-1886, 2,740 in 285,882; in 1886-1887, 1,786 in 310,840; in 1887-1888, 2,333 in 419,848; in 1888-1889, 2,328 in 479,124; and in 1889-1890, 1,887 in 442,115. Thus, as an average for the seven years, one measly hog was found in each 173 slaughtered. In 1895-1896, the relation of measly hogs to the total number of slaughtered hogs was 1 to 1,000; and in 1896-1897, 1 to 1,363.

In southern Germany, measly hogs are rare.

In the Kingdom of Prussia, hog measle worms are much more frequent in the eastern provinces than in the western. Thus, in 1892 the ratio of measly hogs to the total number of slaughtered hogs in the governmental district of Marienwerder was 1:28; in Oppeln, 1:80; in Königsberg, 1:108; in Stralsund and Posen,

1 : 187, and in Danzig, Frankfurt, and Bromburg, 1 : 250, as contrasted with Arnsberg with a proportion of 1 : 865; Coblenz, 1 : 975; Düsseldorf, 1 : 1,070; Münster and Wiesbaden, 1 : 1,900. The average proportion of measly hogs for the whole Kingdom of Prussia was 1 : 1,290, and for the eastern provinces 1 : 604.

The diminution in the number of measly hogs is best shown by the following percentage computation:

(a) Kingdom of Prussia.

Year	*Percentage of measly hogs*
1876–1882	0.324
1886–1889	.181
1890–1892	.122
1899	. 09

(b) Kingdom of Saxony.

1894	0.157
1896	.017
1899	.010

(c) Berlin.

1883–1890	0.577
1892–1893	.319
1895–1896	.099
1899	.043

Concerning the frequency of *Cysticercus cellulosæ* in hogs slaughtered in foreign countries, there are only meagre data. According to Krabbe, only one measly hog was found among 1,334,000 slaughtered at the abattoir in Copenhagen. On the other hand, Prettner found 3.44 per cent. of the hogs slaughtered in Prag to be infested with cysticerci. Moreover, of the hogs imported from Russian Poland into Myslowitz, Beuthen, Kattowitz and Tarnowitz, more than 1 per cent. were measly.

Occurrence of Cysticercus cellulosæ in Other Animals.—In addition to hogs, *C. cellulosæ* may be found occasionally also in sheep, dogs, bear and deer. Furthermore, according to Braun, this parasite may occur in cats, rats and apes.

During the sanitary police inspection of slaughtered dogs in recent years, cysticerci have frequently been found; for example, in 1890, a dog was found in Chemnitz extensively infested with cysticerci.

Caseified and Calcified Hog Measle Worms.—The hog measle worm, as well as the beef measle worm, may undergo regressive metamor-

phosis. This alteration, however, is more rarely observed in the former than in the latter. As a rule, hog measle worms appear to degenerate at a very early developmental stage. The dead cysticerci appear as elongated or spherical caseified or calcified structures which usually stand at the limit of microscopic visibility, but occasionally reach the size of hempseed. Caseified hog measle worms have a gray color, while calcified specimens are pure white. Caseation and calcification are observed in both slight and extensive invasions, but are more frequent in the latter case. Moreover, in hogs, as contrasted with cattle, as a rule all of the cysticerci are affected with regressive metamorphosis, excepting only the rare cases of extensive invasion in which, in addition to the musculature, also the liver, lungs and other vital organs are infested with cysticerci; for the cysticerci in the viscera, especially those in the liver and lungs, usually disintegrate at an early stage, while the muscle cysticerci undergo further development in a normal manner.

When numerous cysticerci have disintegrated, the heart and skeletal musculature is found to be sprinkled with white granules ("calcareous concretions"). Under the microscope, a tough connective tissue membrane and a more or less strongly calcified center may be demonstrated in the calcified structure (Fig. 132). Under certain conditions, calcareous corpuscles and hooks are to be demonstrated in the center.

Fig. 132.

Bladder worm calcified at a young stage, with strongly developed connective tissue capsule. × 35 diam.

Extensive Infestations.—In hogs, much more frequently than in cattle, one observes extensive invasions of cysticerci. This fact is sufficiently explained by the method of managing hogs, as well as by their nature as omnivorous animals in the broadest sense. As many cases of extensive as of slight infestation are observed in hogs. The invasion of cysticerci may be so extensive that the parasites lie side by side in such a manner as to leave only frag-

ments of active muscle substance intact. In such degrees of infestation the musculature is discolored grayish-red and quite watery. In slighter cases of infestation this is never the case. Moreover, in cases of extensive invasion one frequently finds cysticerci in the lymphatic glands, panniculus adiposus and brain. On the other hand, even in extensive invasions, cases in which the lungs, liver, and other viscera, in addition to the musculature, are infested with cysticerci, are very rare.

Ratio of Extensive to Slight Cases of Invasion in Hogs.—In the years 1884 to 1887, according to statistics in Berlin, the ratio of extensively infested hogs to those slightly infested with cysticerci was as follows:

Year	*Extensively infested*	*Moderately infested*	*Slightly infested*
1884–5	542	489	436
1885–6	1,002	743	995
1886–7	623	409	371

Hogs in which, despite a careful examination of all muscle surfaces which are exposed by the ordinary commercial cutting up of the animals, *only one specimen of Cysticercus cellulosæ* could be demonstrated, were found in the following numbers, according to the statements of Hertwig: In 1885–6, 156; in 1886–7. 279; in 1887–8, 408; in 1888–9, 446; and in 1889–90, 317.

Later in Berlin it was found convenient, from practical considerations, to make a distinction only between extensively and slightly infested hogs. Inspection of hogs gave the following results:

Year	*Total number of measly hogs*	*Extensively infested*	*Slightly infested*
1895–6	627	304	323
1896–7	509	251	258
1899	325	118	207

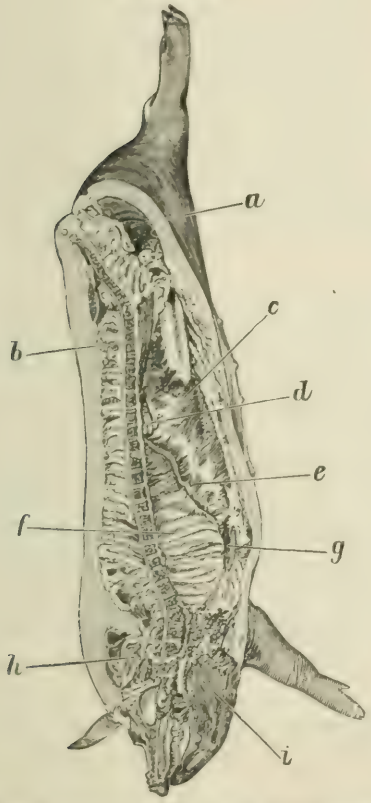
Most Frequent Locations.—The usual seat of the hog measle worm is in the abdominal muscles, muscular portion of the diaphragm, lumbar muscles, tongue, heart, muscles of mastication, intercostal muscles and cervical musculature, the gracilis, and sternal musculature.* These preferred locations of *Cysticercus cellulosæ* must be most carefully examined in all slaughtered hogs,

* For the purpose of inspecting the abdominal muscles, a previous removal of the retroperitoneal fat tissue is indispensable, and for inspecting the cervical musculature, it is necessary that the hog be split into two lateral halves.

and, like the heart and muscles of mastication, must in all cases be tested by incision.

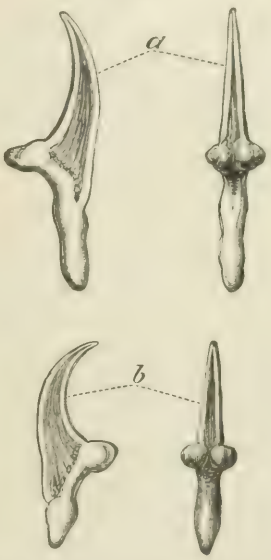
Among the vital organs, the heart and brain should be named as frequent locations for the hog measle worm, and among the other organs the lymphatic glands and panniculus adiposus.

Fig. 133.



Preferred locations of the pork bladder worm. *a*, gracilis; *b*, lumbar muscles; *c*, abdominal muscles; *d*, pillars of the diaphragm; *e*, costal portion of diaphragm; *f*, intercostal muscles; *g*, sternal muscles; *h*, neck musculature; *i*, internal masticatory muscles.

Fig. 134.



Hooks from Cysticercus cellulosæ, seen from the side and in front. From photographs. *a*, large hooks; *b*, small hooks. × 275 diameters.

Cysticercus cellulosæ is found in the other viscera only exceptionally and, as a rule, only in case of extensive invasion. In such cases the cysticerci are observed in the lungs, liver and spleen. Prettner found the eye to be an exceptional site of cysticerci. He examined the eyes of 409 measly hogs and discovered

cysticerci in the interior of the eyes in a subretinal position in two of the hogs.

The frequent occurrence of hog bladder worms in the musculature of the tongue is utilized by meat dealers in diagnosing infestation by cysticerci in living animals. For this purpose hogs are thrown upon their side and the mouth opened with a stick. The tongue is then drawn out with a cloth and subjected to inspection and palpation for the presence of cysticerci. Hogs thus recognized as measly during life, form a favorite material for trade in localities without regular meat inspection. This dangerous practice is to be checked in all possible ways. A legal means of accomplishing this purpose is furnished by the food law, which, according to several decisions of the Imperial Court (page 111), is applicable also to living food animals, and, therefore, provides a penalty according to Section 12 for the sale of living hogs known to be measly.

Diagnosis.—The diagnosis of fully developed hog measle worms presents as little difficulty as the recognition of developed beef measle worms. In hog measle worms which have undergone an alteration of their appearance, color and size in consequence of regressive metamorphoses, the calcareous corpuscles (Fig. 125) and also the hooks (Fig. 134) demonstrate the presence of the remains of cysticerci. These diagnostically important parts are wanting only in cases where the hog measle worms have degenerated and become completely calcified before the formation of the scolex. In this case, however, their position in the interfibrillar muscle tissue and the presence of a strong connective tissue capsule furnishes the means of making a probable diagnosis.

In case cysticerci are present in the viscera, the demonstration of *Cysticercus cellulosæ* must be made by means of a microscopic examination.

Differential Diagnosis.—With regard to a differential diagnosis, attention should be called to the fact that the harmless *Cysticercus tenuicollis* has been confused with the dangerous *C. cellulosæ* (Fig. 99). The harmless cysticercus, however, is distinguished from the dangerous one, as should be again emphasized, by its exclusive occurrence under the serous covering of the viscera, in the latter, and under the peritoneal covering of the abdominal muscles and diaphragm. *C. tenuicollis* is not found in the musculature. Furthermore, after removing *C. tenuicollis* from its cysts, its

long neck is conspicuous (Fig. 100). And, finally, this parasite possesses from 32 to 40 hooks, as contrasted with the 22 to 28 of *C. cellulosæ*. With regard to the hooks themselves, those of *C. taeniæformis* are longer, slenderer and more curved at the points than the hooks of *C. cellulosæ*. Moreover, Schwarz called attention to the form (resembling a thumbnut) of the basal processes of the small hooks in *C. taeniæformis*. This condition was not observed by Schwarz in *C. cellulosæ*. It should not be forgotten, however, that even on the small hooks of *C. cellulosæ* a bifurcation or a median groove is indicated (Figs. 102, 134).

Schwarz examined 1,000 specimens each of *C. cellulosæ* and *C. taeniæformis* from different localities and found that in the former species there are usually 22 to 28 hooks; in the latter, 28 to 36. Moreover, during his observations, Schwarz noted that in *C. taeniæformis*, as a rule (in 75 per cent. of the circles of hooks which were investigated), one or more small hooks were demonstrable, the basal process of which was bifurcated. In the 1,000 specimens of *C. cellulosæ* examined by Schwarz, this was not the case in a single instance. Reissmann has confirmed these observations.

Judgment.—Measly pork is not merely harmful to human health like measly beef, but is dangerous. For, not only does a tapeworm, *Taenia solium*, develop from the cysticercus, but there may occur the production of cysticerci in the human body by autoinfection of the host with the larvæ of this tapeworm. Most probably this autoinfection is brought about by the fact that ripe proglottides of *T. solium* make their way into the stomach in consequence of an antiperistaltic movement of the intestinal contents, and in this situation embryos have an opportunity, under the influence of the gastric juice, to emerge from the eggs. On the other hand, it is possible that persons of uncleanly habits infested with tapeworms soil their fingers, during defecation, with excrement containing eggs and thus introduce the eggs into the stomach along with food. However this may be, the fact remains that *C. cellulosæ* occurs rather frequently in man as compared with *C. bovis*, which has never been demonstrated with certainty in man. The danger of self-infection with the larva of *T. solium* lies in the fact that in man the cysticerci become located not only in the muscles but also in the vital organs, especially in the brain and eyes.

Concerning the frequency and location of *C. cellulosæ* in man, Haugg has collected the following statistics:

Among 87 persons infested with cysticerci, Dressel found cysticerci in the brain in 72 cases; in the muscles, on the other hand, in only 13 cases. Among 36 cases investigated by Karl Müller, cysticerci were found in the brain in 21, in the skeletal musculature in 12, and in the heart in 3 cases. Gribbohm described six cases, in which the brain was infested in 5 and the brain and muscles simultaneously in one. Five cases described by Sievers showed cysticerci in the brain in all. In one case, however, cysticerci were also present in the muscles. Finally, Haugg himself, from autopsies at the Pathological Institute in Erlangen (1874 to 1885), collected 25 cases, in 13 of which the brain was infested, the muscles in 6 and the subcutis in 2 cases. The muscle most frequently infested was the pectoralis major. Von Gräfe (in 80,000 patients with eye disease) observed cysticerci in the eye in 90 cases, and Everbusch has observed two such cases since 1874. According to Gast, 9 cases of intraocular cysticerci were observed at the Breslau Eye Clinic between 1885 and 1889.

In southern Germany, thanks to the long existence of regulated meat inspection, cysticercus disease of man is rarer than in northern Germany. In Würtemburg, for example, according to Schleich, only six cases of ocular cysticerci have ever been observed; and in Munich, according to Bollinger, in 14,000 cadavers, only two cases of cerebral cysticerci were observed. Recently a diminution in the extent of the cysticercus disease has been noted also in Berlin. According to Virchow, the proportion of cysticercus infestation in the brain has diminished since the introduction of meat inspection from 1:31 to 1:280 of the autopsies. In Berlin, Hirschberg, in the years from 1869 to 1885, found 70 cases of cysticerci in the eye among 60,000 eye patients; in the following six years, however, only two cases among 46,000 eye patients, and of these one came from Saxony.

However, like measly beef, measly pork is also dangerous only in a raw condition. The latter, like the former, may be rendered harmless by pickling and boiling. In this regard, essentially the same statement may be made for the hog measle worm as was made concerning the beef measle worm, and likewise with regard to the utilization of measly meat in slight and extensive invasions in cases of the presence of undeveloped or degenerated cysticerci and with regard to the utilization of the viscera free from cysticerci. The hog measle worm, however, is distinguished from the beef measle worm by the fact that it is somewhat more resistant to heat. The

hog measle worm is not killed until a temperature of 49° C. is reached. A further difference consists in the fact that the hog measle worms remain alive much longer than the beef measle worms after the death of their host. While beef measle worms are always found dead after a period of twenty-one days, I have found living hog measle worms in meat which has been slaughtered forty-two days. Measly pork, therefore, can not, like measly beef, be rendered harmless by preservation in cold storage. This, however, is without practical significance, since hog measle worms are of much rarer occurrence than beef measle worms and since boiled or pickled measly pork can always be sold readily at a reasonable price. Measly pork is to be considered as harmless if it has been boiled so that the cut surface possesses a uniformly white color.

Official Regulations Concerning the Method of Procedure with the Meat of Measly Hogs.*

With regard to the utilization of measly hogs, the following ordinance was passed in the Kingdom of Prussia, February 16, 1876:

In response to the report of October 23 of last year concerning the complaint of the Master Butcher N——, on account of the destruction of measly pork ordered by police authority, we send the inclosed certified copy of the opinion given on this question by the Royal Scientific Deputation for the Medical Service, with the request that in cases of police regulations concerning hogs infested with cysticerci the suggestions made at the conclusion of the opinion should serve as a guide for legal action; that the local police president as well as the other police authorities of the district should be furnished with these instructions and that N—— should be informed accordingly.

OPINION.

Your Excellency has requested of the undersigned Scientific Deputation for the Medical Service an opinion concerning the regulations which have been made in the interests of the sanitary police with regard to hogs found infested with cysticerci. The Deputation accordingly incloses herewith the required opinion:

1. That fat obtained from measly hogs by rendering or cooking may be utilized unconditionally, but that lean meat can only be admitted for sale or for use in one's own household in cases where it is only slightly infested with cysticerci and is thoroughly boiled under police supervision after having been previously cut up.†

2. That no objection whatever, from a sanitary police standpoint, can be raised against the use of suitable parts of measly hogs in the preparation of soap or glue,

* These regulations will become applicable throughout the whole German Empire as soon as the Imperial Meat Inspection Law comes into force.

† According to a decision of the Second Criminal Senate of the Imperial Court, March 25, 1884 (p. 106), the rendered fat of measly hogs is to be sold under declaration.

or against the free utilization of the skin and bristles, and the chemical utilization of the whole body; and that these uses are to be permitted without hesitation.

3. That in all cases in which hogs are found to be badly infested with cysticerci, care must be exercised by the police to secure the certain destruction of the carcass after this has been utilized so far as admissible.*

With reference to the utilization of viscera free from cysticerci, a decree of the Ministries of Interior and Education, June 26, 1883, permits the fat, liver and intestines of hogs found to be measly to be freely admitted to the market as food for man, provided they have been found, upon examination, to be free from cysticerci.

In Bavaria the following regulations are in force, in accordance with the opinion of the Royal Superior Medical Committee, May 20, 1882:

1. The meat of hogs extensively infested with cysticerci is to be withheld from consumption and from the public market and is to be rendered harmless in a suitable manner. In the case of fat hogs, the separation and removal of the bacon is to be allowed at the request of the owner. No objection can be raised to the technical utilization of such animals.

2. In cases where the cysticerci occur only sparingly in the meat, it may, according to the opinion of a scientific meat inspector and after it has been properly cooked under police supervision, be turned over to the owner for use in his own household. The owner is to be properly instructed concerning the danger to human health from measly meat and is to be made cognizant of the police regulations concerning the control of such matters.

3. The public sale of meat slightly infested is to be permitted in freibanks under declaration of the danger from the meat, only after it has been properly cooked under police supervision.

In the Kingdom of Saxony, the meat of hogs slightly infested with cysticerci is to be admitted to the market in a cooked or pickled condition as non-marketable. The fat may be treated by rendering instead of boiling or pickling. The liver, spleen, kidneys, stomach and intestines of measly hogs may be utilized in a raw condition as non-marketable, provided they are found to be free from cysticerci by veterinary inspection.

(c) Trichina Spiralis.

Zoological Position.—According to the classification of Schneider, trichina belongs to the third group of nematodes, the Holomyaria. It is the only representative of its genus. Other

* In the Prussian Governmental district of Arnsberg, it is provided that all measly hogs, whether found to be slightly or badly infested with cysticerci, are to be utilized for technical purposes only. There is no scientific basis for such a rigorous procedure.

nematodes have been erroneously considered to be trichinæ.* Distinction is made between sexually immature individuals located in the intestines and the larvæ which are found in the musculature. It is only the latter, the so-called muscle trichinæ, which possess sanitary police interest, for they occur spontaneously in one food animal, the hog, and may be transmitted through the meat to man and cause in man a serious disease—trichinosis.

With regard to the history of trichina, it should be stated that the English physician, Hilton, in 1832, first investigated calcified trichinæ in the human cadaver, without, however, having discovered the worm in the capsule. According to Zürn, these structures were observed in 1822 by Tiedemann, in 1828 by Peacock. The worm contained in the capsule was first noticed by Paget in 1835 in an Italian dead of tuberculosis, and was described by Owen, who received material from Paget, as the spiral hair worm (*Trichina spiralis*). After this determination and description, the matter rested. Other observations, to be sure, were published concerning the occurrence of encapsulated trichinæ in man, for example, in England, in Berlin, Heidelberg, and in North America. Furthermore, the parasite was found by Leidy in a hog in Philadelphia in 1847 and in a cat by Herbst in Göttingen, and by Gurlt in Berlin. Moreover, in 1850, Herbst succeeded in infecting a badger with encapsuled trichinæ from a dog; and by means of the meat of the latter, two dogs were rendered trichinous. The sanitary police significance of trichina was, however, first recognized in 1860, as a result of an observation of Zenker and the experimental investigations of Leuckart and Virchow.

Zenker was the discoverer of trichinosis. As professor of pathological anatomy and general pathology at the Surgical-Medical Academy in Dresden, he held an autopsy in 1860 on a nineteen-year-old girl who had been received in the Dresden City Hospital as a typhoid patient and had received treatment at that place. In

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*So-called false trichinæ occur in various animals: for example, in the musculature and other parts of hare, rats, mice, moles, birds and fish, nematodes are sometimes found which, in their external form, possess a certain resemblance to trichina, and have consequently been considered as such by uninformed persons. To this group belong the ascarids found in the muscle meat of moles, the filaria larvæ which occur under the serous coat of the intestines in rats, the round worms in the mesentery and liver of white fish, the muscle nematodes in mice, frogs and eels (Leuckart); also the larvæ of *Strongylus retortæformis* in the liver of hare; the larval forms of ascarids in pike and carp; the filaria larvæ under the serous coat of the intestines of ducks, and several species of filaria in moles, hedgehogs, lizards, meal worms, etc. For further details, see Johne, "Der Trichinenschauer."

Fig. 135.

Intestinal trichinæ. *A*, female giving birth to young; *B*, male. × 100 diam. (after Heller).

making the post mortem on the girl, the intestinal alterations characteristic of typhoid were not found. On the other hand, Zenker found sexually mature trichinæ in the intestines and numerous non-encapsuled trichina larvæ in the muscles. Further investigation showed that the girl took sick at Christmas time after eating pork and that the butcher who had furnished the meat, as well as several of his customers, also became ill. Several salted pieces of the suspected meat were found which were badly infested with trichinæ. This demonstration of Zenker, which was corroborated by Virchow and Leuckart by simultaneous experiments with some of Zenker's material, furnished proof of the surprising fact that trichina, which had until then been considered as a harmless commensal organism, was a dangerous enemy of man. Leuckart fed the musculature of the trichinous girl to a dog and also fed an intestine of the dog, filled with pregnant trichinæ, to a hog, while Virchow undertook a transmission experiment by feeding Zenker's material to a rabbit. On

precisely the same day Leuckart and Virchow demonstrated the presence of non-encapsuled muscle trichinæ in their experimental animals and thereby determined the fact that muscle trichinæ could be produced by feeding meat which contained trichinæ to suitable experimental animals. The connecting link which plays the most important rôle in this transmission, the sexually mature developmental stage of the parasite in the alimentary canal, was already known as a result of the previous researches of these investigators (1859). Several days before the above mentioned discovery of Leuckart and Virchow, Zenker investigated the intestine of the dead servant-girl, which had been preserved in cold storage, and demonstrated intestinal trichinæ in the first drops of intestinal mucus which he examined.

Soon afterward, the outbreaks of trichinosis in Hettstädt (1863) and Hedersleben (1865), in which 500 human beings were affected and 129 died, furnished the awful confirmation of the suspicions which had been entertained regarding the dangerousness of trichinæ.

It has been asserted that trichinæ were introduced into Europe from Asia by migrating rats. According to Gerlach, however, trichinæ were quite probably introduced into Germany in Chinese hogs which, during the 20's and 30's of the previous century, were used in England and northern Germany for crossing with native races in order to increase their fattening power. Trichinosis is said to be frequent in China and the small Chinese hogs were utilized in Germany, especially in those regions which later formed the center of distribution of trichinæ in the province and kingdom of Saxony. As Gerlach rightfully insists, no trichinæ were found in Europe previous to the 20's and 30's. This speaks for the correctness of the assumption of Gerlach against the migrating rat theory, since the migrating rats came to Germany about the year 1770. Between the 30's and 50's trichinæ were found accidentally in human cadavers in isolated cases, and once in a hog, a dog and a cat. It was not until the 60's that the distribution of trichinæ increased and became permanently established in infested localities.

Biology.—After the ingestion of trichinous meat, sexually mature, so-called intestinal trichinæ develop in the intestines of certain mammals and birds, after the muscle parasite has been set free from its capsule by the gastric juice. Even within thirty to forty-six hours, developed trichinæ are found in the small intestines where the males and females copulate before the second day. The female trichina, which reaches a length of 3.5 mm. or more, as con-

trasted with a length of 1.2 to 1.5 mm. of the male, is viviparous. The first embryos are observed within six to seven days after feeding trichinous meat. The embryos when first born are slender, rod-like structures about 0.1 mm. long and 0.0056 to .006 mm. in width. The expulsion of the embryos takes place by pressure from behind. According to Leuckart, a female trichina gives birth to not less than 1,500, and, according to Braun, to from 8,000 to 10,000. The number of sexually mature males and females in the alimentary tract is at first equal; later the number of males diminishes more and more, and at from ten to fourteen days after infection one finds almost exclusively female trichinæ (J. Vogel). From this fact we may conclude that the male trichinæ die soon after copulation and are digested or carried out with the feces. The females have an average life of from five to six weeks, but may live for twelve weeks.

Leuckart, Pagenstecker, *et al.*, have assumed that female trichinæ give birth to embryos in the lumen of the intestine, and that the latter, after a short sojourn in the intestinal mucus, penetrate the intestinal wall, enter the peritoneal cavity, thence into the thoracic cavity, and finally, following the course of the strands of connective tissue, migrate actively into the voluntary musculature. Probstmayr, however, emphasized the fact that it is not possible to demonstrate trichina embryos in the intestinal contents. Moreover, Heitzmann rightfully argued against the migration theory, that the embryos at first possess no boring apparatus, and that, since they are found in the skeletal muscles within a few days, they must have travelled a tremendous distance, as compared with their size. Heitzmann, accordingly, considers it as certain that the trichina embryos are carried into the blood circulation by means of the lymph stream and are caught as emboli in the capillaries of the striated muscles.

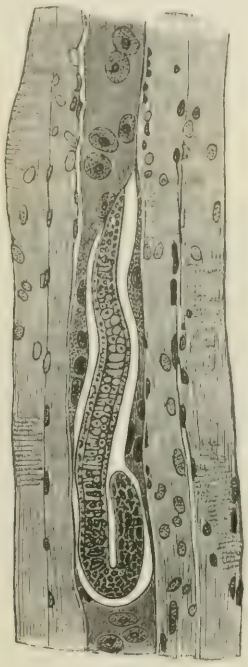
The assumption of the translocation of the embryonic trichinæ by means of the circulating blood was substantiated by the almost simultaneous researches of Cerfontaine, Geisse and Askanazy, but especially by the thorough-going experiments which were instituted by Graham in Munich under the direction of Hertwig. In harmony with the statement of Geisse, Graham found that the intestinal trichinæ, both males and females, bore into the interior of Lieberkühn's glands with the anterior end of the body, and that while in this position the females expel the embryos which are carried into the circulating blood through the chyle vessels. Graham demonstrated with certainty that the trichina embryos

make their way into the blood through the thoracic duct and are carried into the muscles by the circulating blood. In agreement with this finding, we have the occurrence of trichina embryos in the lymph glands observed by Virchow and later by Askanazy and Graham, and the finding of trichinæ in the blood by Zenker, Colberg, Probstmayr and Fiedler.

Fig. 136.

Isolated muscle fiber from a rat, which was killed 16 days after the first and 9 days after the last feeding with trichinous meat. × 510 diameters. A migrating trichina. The posterior end was pulled out of the muscle fiber in preparation (after Hertwig).

Fig. 137.



Longitudinal section through the musculature of a rat, which was killed 19 days after the first and 10 days after the last feeding. × 310 diameters. Disappearance of striation in muscle fibers penetrated by trichinæ and great multiplication and enlargement of the muscle nuclei near the trichinæ (after Hertwig).

Trichina embryos were never seen by Graham in the free spaces of the body cavity in which they must first appear if they travel by active migration. Whenever they are found in that situation, the fact is to be explained by an injury to the thoracic duct or blood vessels during exenteration of the peritoneal cavity.

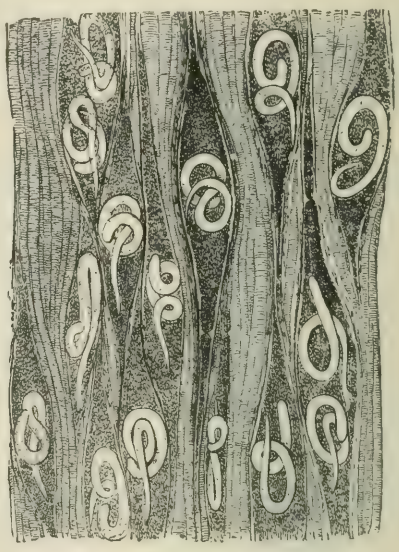
Graham was able to demonstrate trichina larvæ in sections in a small artery and in muscle capillaries. By way of confirmation

of a view held by Van Beneden, Graham also observed, not infrequently, larvæ which passed out of the capillary as a result of stasis or hemorrhage. From the capillaries the trichina embryos make their way immediately into the sarcolemmal sheath (Fig. 136). From the existence of canals which Graham observed behind trichinæ, it is to be concluded that trichina embryos are able to migrate into the sarcolemmal sheaths. The migration finds its natural limit in the tendons and aponeuroses, whereby the accumulation of trichinæ at these points is explained.

Fig. 138.

Muscle trichina .4 mm. long, 15 days after feeding (Leuckart).

Fig. 139.



Muscle trichinæ, 7 weeks old, in the enlargements of the sarcolemmal sheaths (Leuckart).

One observes the first trichina larvæ in the musculature within seven or eight days after infection of the experimental animals. The youngest stages of the muscle trichinæ are 0.1 mm. long and are therefore of the same size as the trichina embryos at birth. This fact argues likewise for the distribution of the trichinæ by the circulating blood. According to a statement of Gerlach, the greatest number of migrating muscle trichinæ are to be found between the twelfth and twentieth days.

After the end of the period of migration into the muscle fibers the trichina embryos pass into a stage of rest, in order to grow. A loss of the transverse striation takes place in the sarcolemmal

sheaths which are affected by the invasion of the trichina embryos. The muscle fibers assume at first a homogeneous, and later a granular character. Furthermore, the muscle nuclei increase in number and finally become so large that their transverse diameter about equals one-half the diameter of the muscle fibers (Fig. 137). A granular mass lies around the nucleus.

The growth of the trichinæ is complete about three weeks after feeding trichinous meat. Their size then reaches 0.8 to 1 mm. After their growth is completed, the muscle trichinæ assume a variously curved and coiled form with simultaneous fusiform distension of the sarcolemma (Fig. 139). During the course of the second month the trichinous muscle fibers collapse in consequence

FIG. 140.

Encapsuled trichina. Trichina capsule with persistent sarcolemma and polar fat cells. (Leuckart.)

FIG. 141.

Primary calcified trichinæ with intact capsule, × 35 diameters.

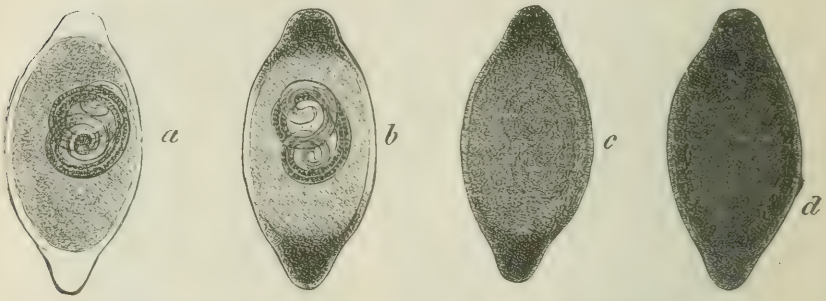
of the resorption of the disintegrated contractile substance. Simultaneously the first appearance of the trichina capsule at the poles of the fusiform enlargement is noted. At the end of the third month, the trichinæ are enveloped by fully developed capsules which lie in the long axis of the muscle fibers (Fig. 140). After the encapsulation of the trichina larvæ in well fed animals, a development of fat cells frequently takes place in the collapsed sarcolemma immediately around the poles of the trichina capsules. This polar fat tissue may be so extensive as to render the trichinæ recognizable by the naked eye (Figs. 143, 144).

The ultimate fate of muscle trichinæ varies. According to

Leuckart, we may observe incipient calcification of the capsules within six months after the animals have been affected (Fig. 142, *b*). According to the same author, a period of 15 or 16 months is necessary for the complete impregnation of the capsules with lime salts (Fig. 142, *d*). These statements, however, do not agree with the experience of practical meat inspectors. Thus, in two hogs 9 and 12 months old, Blome found completely calcified trichina capsules, the original form of which became again apparent after treatment with hydrochloric acid. The trichinæ may become visible even to the naked eye as a result of complete calcification.

The process of calcification is usually confined to the capsules, so that perfectly intact trichinæ may be found in capsules which are totally calcified. According to Leuckart, the parasites

FIG. 142.



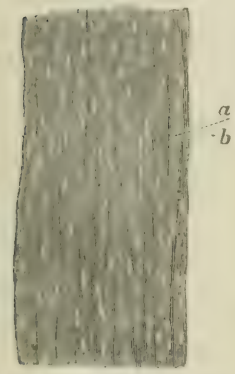
Normal calcification of trichinæ in different stages.
a, intact trichina; *b*, calcification of the poles; *c*, incomplete calcification, the parasite being visible; *d*, complete calcification.

themselves become calcified under normal conditions after a long period (ten years or more). It has also been demonstrated that muscle trichinæ more than ten years of age may possess perfect vital powers. Thus Dammann demonstrated that trichinæ $11\frac{1}{4}$ years old were still capable of producing infestation, and Langerhans demonstrated this power for isolated trichinæ in one case in which the age of the parasite was probably 31 years. In the case reported by Dammann, it was a striking fact that the trichina capsules were not completely calcified, but were so transparent that the trichinæ contained in them could be seen. Leuckart expressed the opinion that trichinæ do not calcify until after the capsule is completely incrusted with lime salts. The writer, however, has observed primarily calcified trichinæ in perfectly transparent capsules in hogs (Fig. 141).

The question has been raised concerning the reason why trichina larvæ occur only in the musculature and not in other organs; also why it is that trichinæ are found in certain striated muscles more frequently than in others, and in one, the heart, not at all. These facts appear not to harmonize completely with the distribution of trichina embryos by means of the circulating blood.

To the first question Graham gave the satisfactory answer that the doctrine of the exclusive infestation of the muscles was based on the occurrence of encapsuled trichinæ. Thudichum has demonstrated that in artificially infested animals trichina embryos may be

Fig. 143.



Trichinous hog musculature with unusually strong development of the polar fat tissue. *a*, trichina capsule; *b*, fat tissue. Natural size.

Fig. 144.

Trichinous hog musculature with unusually strong development of the polar fat tissue. × 35 diameters.

found within seven days after infestation in the muscles, lungs, thymus and lymphatic glands. Virchow also, and others, as already mentioned, have observed the occurrence of trichinæ in the lymphatic glands and Askanazy observed them in the lungs. If later no encapsuled trichinæ are found in these locations, this condition is due, according to the researches of Graham, to the fact that trichina embryos are unable to grow except inside of striated muscle fibers which are provided with sarcolemma and that in all other parts of the body they disintegrate after a short time. Trichinæ die even in the perimysium internum if they do not succeed in making their way into the muscle fibers immediately after leav-

ing the circulating blood. The fact should be emphasized that Graham, contrary to the statement of Chatin, never saw trichinæ either free or encapsuled in the adipose tissue. For the rest, the localization of trichina embryos in the musculature is favored by the fact that the newly born trichinæ are of about the thickness of the muscle capillaries, which, together with those of the retina, are the smallest in the body. If, now, the lumen of the capillaries is lessened by contractions of the muscles, the trichina embryos, which can pass through all other capillaries, excepting only those of the lungs, are prevented from moving farther. Trichina embryos have been found by Askanazy in the lung capillaries, which may be constricted during expiration.

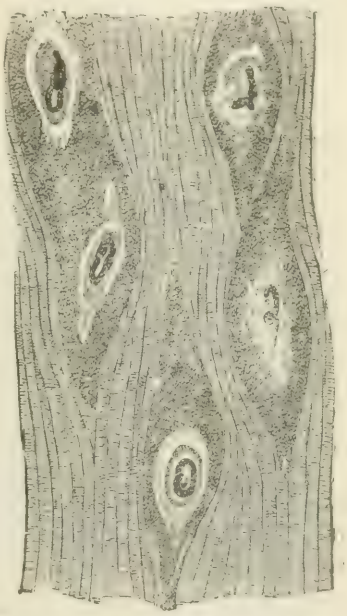
Encapsuled trichinæ have never been found in the musculature of the heart. On the other hand, Thudichum observed a free trichina between the myocardium and the endocardium, a second immediately under the endocardium, and a third between the muscle fibers of the myocardium. Graham frequently saw embryos in large numbers in badly infested rats between the fibers of the myocardium which were partly penetrated and otherwise injured. The trichinæ, however, always remain outside of the muscle fibers, since the sarcolemma is wanting and the disintegrated contractile substance floats away. Furthermore, trichinæ do not find the required conditions for their growth in the myocardium and therefore disintegrate in this organ. One finds embryos inside of small inflammatory foci, in which position they die. Moreover, the embryos which have made their way into the myocardium migrate out into the pericardium, in which they may be present in large numbers (Graham).

Trichinæ are not found uniformly distributed in the rest of the striated musculature. Certain muscles and groups of muscles are, with great regularity, more extensively infested with parasites than others. These muscles are characterized as preferred locations of the parasites. Among these preferred sites for trichinæ, mention may be made of the muscular portion of the diaphragm, muscles of the larynx and tongue, and to a less degree, the abdominal and intercostal muscles. The striking preference of trichina for the respiratory muscles is explained by Graham as due to their greater richness in blood and by Heitzmann as due to the regular contractions and consequent diminution of the lumen of the capillaries. Undoubtedly the fact emphasized by Heitzmann plays the chief rôle in entrapping the trichina embryos. The same fact may also explain the frequency of trichinæ in the tongue of the hog, since

this muscular organ in hogs fed in confinement is used most frequently of all the muscles which come into function periodically.

Pathological Encapsulation of Trichinæ.—Leuckart was the first to report the frequent finding of muscle trichinæ in hogs, in which the connective tissue membranes which arise as a result of reaction toward the surrounding tissue become so greatly distended as to reach the length of 1 mm. These abnormal proliferations of connective tissue prevent the formation of true transparent chitinous trichina capsules and occasion the premature death of the enclosed parasite with a final deposition of lime salts. Calcification in such cases may be so complete that no trace of the trichina itself remains after the lime salts have been dissolved by acids. Only the peculiar fusiform shape, the size not exceeding 0.5 to 1 mm., and the position of the structures in the muscle fibers demonstrate that we are dealing with the remains of trichina (Figs. 145, 184).

FIG. 145.



Pathologically altered trichina capsules with proliferating connective tissue membranes and dead worms. From a hog. (Leuckart.)

Degeneration of Trichinæ.—In the case mentioned above, Langerhans observed alterations in the trichinæ and their capsules which must be considered as phenomena of degeneration. Some of the capsules were quite empty; in others with a perfectly intact wall, recently formed connective tissue and adipose tissue were found which had originated from included cells. The trichinæ were disintegrated and entirely or partly resorbed. Langerhans believed that he was justified in concluding from his researches that a decalcification and even a resorption of the capsules may take place after the disappearance of the trichinæ. Accordingly, contrary to the belief entertained up to this time, an invasion of trichinæ does not terminate with their calcification, but with their complete resorption.

Morphology.—Non-calcified, but completely developed, muscle trichinæ consist of a lemon-shaped, or more nearly spherical, transparent, double-contoured trichina capsule, and the spirally coiled worm. According to Dammann, the length of the trichina capsule is about 0.495 mm.; the width, 0.415; and the thickness of the capsule wall, 0.05 mm. The length of the worm is 0.8 to 1 mm. and its greatest breadth, 0.03 to 0.055 mm. In muscles which still possess animal heat, one observes tactile movements executed by the anterior end of the worm in its capsule. In cold muscles it is possible to induce these movements by treatment with warm water or concentrated potash lye, and thereby demonstrate that the muscle trichinæ are still living.

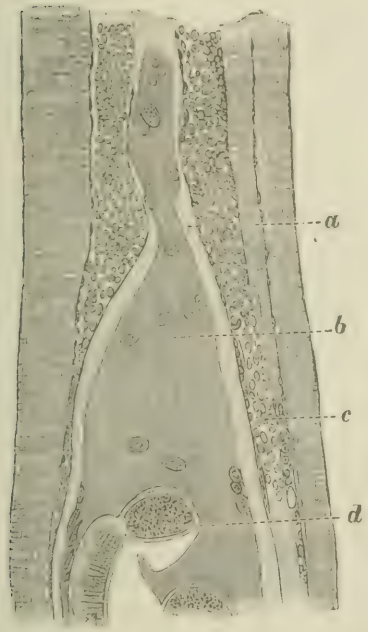
With regard to the finer structure of the muscle trichinæ the following points of diagnostic importance may be mentioned. Muscle trichinæ are provided with a thin transparent and structureless cuticula. The anterior end is pointed, narrower than the posterior end, and furnished with a small, circular mouth opening. The mouth leads into the pharynx, a light-colored tubular structure, which, at its posterior end, passes over into the esophagus, which in turn is surrounded by a band of large nucleated cells, the so-called cellular body. The posterior end is thickened and provided with a cloacal slit. The simple genital sac, which begins blindly at the posterior end of the parasite, is rudimentary (Fig. 148).

The origin of the trichina capsule has been an unsettled question. Virchow attributed the capsules to the sarcolemma; others to the granular tissue which forms around the parasite. Hertwig, in co-operation with Graham, undertook researches on this disputed question, from which it appears that primarily the sarcolemma, with the presence of which, as already mentioned, the development of the trichina embryos is essentially connected, but secondarily also the granulation tissue is concerned in the formation of the trichina capsule. According to Hertwig and Graham, one observes, about four weeks after artificial infection, that the granular nucleated contents of the primitive bundles are degenerated. Nuclei and protoplasm together present a glossy, swollen appearance. Their mass, especially outside of the spindle-like swelling, is considerably diminished. The latter become elongated at both ends into fine threads. The swelling and the threads are surrounded by a gelatinous sheath which was observed by Leuckart and was considered by him to be a thickened sarcolemma (Fig. 139). Upon the outside of the gelatinous sheath there is a zone of

inflamed connective tissue which is extensively permeated with connective tissue cells and leucocytes.

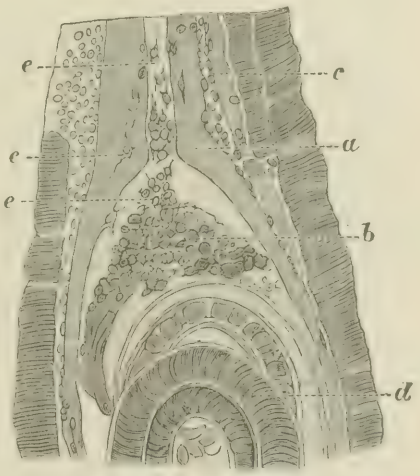
In more advanced stages of capsule formation, one observes the disappearance of the degenerated muscle mass in the region of the thread-like elongations. The connection with the material which surrounds the trichina is broken and in the interior of the gelatinous strand which originated from the sarcolemma one still observes

Fig. 146.



Longitudinal section through the musculature of a rat which was killed 37 days after the first and 30 days after the last feeding. × 310 diameters. *a*, thickened sarcolemma; *b*, remains of disintegrated muscle substance; *c*, proliferating connective tissue cells; *d*, trichina. (After Hertwig.)

Fig. 147.



Piece of a trichina capsule isolated by teasing, from a rat killed 37 days after the first and 30 days after the last feeding. *a–d*, as in Fig. 146; *e*, connective tissue cells which have wandered into the thickened sarcolemma and are organizing the trichina capsule. (After Hertwig.)

here and there the remains of nuclei and granular masses which are gradually being absorbed. At about this time begins the organization of the definite trichina capsule. Cells migrate out from both ends of the inflamed connective tissue and pass into the gelatinous layer which surrounds the trichina and its food material. Small connective tissue cells with branched processes are to be observed in the gelatinous substance and new cells appear also in the detri-

tus with which the trichina is surrounded. They form small groups of cells at both poles (Figs. 146, 147). According to Hertwig and Graham, it is probable that the new, firmer cyst is secreted by the wandering connective tissue cells in the region of the old gelatinous sheath, for the cysts exhibit stratification marks parallel with the surface, and evident cells are still observed between the layers in young capsules, while later the cells are replaced with granular masses which are entirely wanting in the old capsules.

In the account as given by Hertwig and Graham, we find an explanation of the remarkable lemon-like form of the trichina cyst. The wall of the cyst is much thickened at both poles, since the connective tissue cells penetrate at these points and are hence found there in larger numbers than at other points of the periphery.

Occurrence.—Among the animals used for food, only the hog and the dog are infested with trichina. Trichinæ occur also in the wild hog, cat, bear, fox, badger, martin and pole cat.

Trichinæ may be artificially transmitted to a majority of the mammals. Hogs and the small experimental animals of the laboratory, guinea pigs, rabbits, rats and mice, are most susceptible. The transmission to cattle, sheep and the horse is more difficult. After feeding trichinous material to calves and sheep, there is, as a rule, a development of intestinal trichinæ only and no muscle trichinæ. The same is true of birds. Cold blooded animals are not susceptible.

The importance of trichinæ lies in their transmissibility to man. Man commonly becomes infested by eating pork. Occasionally, also, the meat of dogs, cats, foxes, badgers, as well as of bears from the zoological gardens,* may lead to the development of trichinæ in man. The chief source of trichinæ in man, however, is the domestic hog.†

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* Von Bockum found trichinæ also in two hind quarters of bears which were introduced from the Caucasus.

† As contrasted with the numerous outbreaks of trichinosis as a result of eating pork (see page 478), there are but few reports concerning trichinosis as a result of eating wild hogs, although these animals are infested with trichinæ with comparative frequency. Eulenberg reports a case of trichinosis in man which was referable to the consumption of the meat of wild hogs (Lippspringe, 1876). Furthermore, Würtz mentions two cases of trichinosis in man after eating wild hogs. Finally, in recent times an epidemic of trichinosis occurred in Namur as a result of the consumption of the meat of wild hogs. The sanitary police has accordingly taken account of the occurrence of trichinæ in wild hogs by instituting obligatory inspection for trichina

The hog most probably becomes infested by eating trichinous rats. Both the house rat and the migrating rat are the normal hosts of trichina (Leuckart). This statement is substantiated by the fact that rats are infested with trichina very frequently, much more frequently than the hog.

Heller states that among 704 rats from twenty-nine localities in Saxony, Bavaria, Würtemburg and Austria, 8.3 per cent. were trichinous. Of the rats caught about knackers' establishments, 22.1 per cent. were infested, 2.3 per cent. of those around abattoirs, and 0.3 per cent. of those killed in other localities. As a rule, they were badly infested. Leisering examined rats from eighteen knackers' establishments in the Kingdom of Saxony and found that the rats from fourteen of these establishments contained trichinæ. Gerlach determined that the majority of the rats from stalls of the Hanover butchers in which trichinous hogs had been kept were trichinous. Adam found two out of eighteen rats from the knackers' establishments of Augsburg to be trichinous; Franck found two out of thirty-three rats from the Munich slaughterhouse and seven out of seventy-seven from the knackers' establishments of Erlangen, Nürnburg and Kronach; and Fessler found not less than twelve out of twenty-four rats from the city abattoir and meat market in Bamberg to be infested with trichinæ. In Blankenburg, where, until 1868, trichinosis occurred in man for many years in succession, it was shown by Müller that all rats which were captured about knackers' establishments were infested with trichinæ. Röll demonstrated trichinæ in one out of 146 rats in the city of Vienna, seven out of forty-seven rats from knackers' establishments and also in twenty out of thirty-one rats from the Moravian cities Brünn, Ostrau and Privos. Csokor found 5 per cent. of the rats about the slaughterhouses in St. Marx to be trichinous. Trichinæ have also been found in rats in Denmark and Sweden. Genersich found muscle trichinæ in ten and intestinal trichinæ in two out of 183 rats captured in Hungary. The trichinous rats were captured exclusively in two places (Mills). Billings found trichinæ to be

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in all these animals brought to the market. The inspection should preferably take place at the locality where the meat is cut up and sold.

In localities where dogs are slaughtered, these animals must also be inspected for trichinæ (Leistikow), and, in general, an inspection for trichinæ is to be practiced on all animals which are known to be occasional hosts of trichina, if they are utilized in exceptional cases as human food (bears, badgers, foxes and cats). The inspection of slaughtered dogs for trichinæ was introduced into the Kingdom of Saxony by regulation of July 6, 1901.

extraordinarily frequent in rats in Boston. In one of the export abattoirs of that city, all of the rats were trichinous; in a knacker's establishment 76 per cent., and in the city of Boston as a whole, 10 per cent.

The frequent occurrence of trichina in rats is explained by the gregarious habits of the rats in filthy places, such as knackers' establishments and abattoirs, where the offal of trichinous hogs becomes accessible to them; and also by the fact that rats eat the bodies of their own species. Hogs are clever rat catchers and this fact explains the spontaneous occurrence of trichinosis in hogs.

In addition to this method of invasion, the infestation of hogs as a result of eating other trichinous material, such as trichinous pork, plays a subordinate rôle. On the other hand, the distribution of trichina among American hogs is in part to be attributed to feeding upon slaughterhouse offal.

The frequent occurrence of trichinæ in rats about knackers' establishments furnishes an explanation of the fact that hogs fattened by knackers are often all trichinous.

It is worthy of mention that Blome demonstrated that among ten hogs found to be trichinous in the district of Arnsberg during a period of twelve years, one-half were brood sows, although such animals were not killed except in small numbers. This is undoubtedly due to the fact that brood sows reach the greatest age of all hogs and thus have the greatest opportunity for ingesting trichinæ.

For the rest, trichinæ occur in the hogs of all countries. Since the introduction of inspection for trichinæ, these parasites have been demonstrated most frequently in northern Germany. They are found, however, in the practice of organized trichina inspection in isolated cities of Bavaria, and, moreover, have been demonstrated in hogs from Austria-Hungary, Russia, Italy, France, England, Denmark, Sweden and Norway, and with special frequency in hogs from North America.

Statistics concerning the frequency of trichinous hogs are accessible only for Germany and America. In Germany the average per cent. in different years varies between 0.004 (Kingdom of Saxony, 1899) and .014 (Kingdom of Prussia, 1899). In the Prussian governmental district of Posen, there are certain localities in which as high as 1.5 per cent. of the slaughtered hogs are trichinous.* As a rule, about 2 per cent. of American hogs are trichinous.

* In such localities it would be desirable to have a regulation that in all places in which trichinous hogs were found the rats should be destroyed as far as possible and their bodies burned.

In Germany the frequency of the occurrence of trichinosis in hogs has diminished in the course of the last twenty years. This encouraging fact may be regarded as a result of trichina inspection, through which the trichinous hogs are recognized and their meat rendered innocuous. The following figures may serve to indicate the diminution in the numbers of trichinæ in native hogs, the number of trichinous hogs being indicated by a per cent.:

(*a*) *Kingdom of Prussia.*—1878 to 1885, 0.061 to .048; 1888 to 1892, .033 to .043; 1896, .021; 1899, .014.

(*b*) *Kingdom of Saxony.*—1891, 0.014; 1895, .012; 1899, .004.

(*c*) *Berlin.*—1883 to 1893, 0.035 to.064; 1893 to 1899, .022 to .015.

Frequency of the Occurrence of Trichinæ in Foreign Hogs.

(*a*) *United States of America.*—According to Zürn and others, in American pork imported before 1891, the following percentages were found to be trichinous: In Ludwigshafen, 1 per cent.; Hamburg, 1.26; Rostock, 2; Barel, 2; Kiel, 2.36; Göttingen, 3; Bamberg, 3; Gothenburg, 4; Mailand, 4.8; Elbing, 5; Heilbronn, 8.*

At the instigation of the Chicago Board of Health, Drs. Belfield and Atwood examined 100 hogs for the presence of trichinæ in 1868 and of this number 8 were trichinous. According to Salmon, 18,889 hogs were examined for the presence of trichinæ, and of this number 517, or 2.7 per cent., were found to be infested. Of the 999.554 hogs inspected in 1900, 19,448, or 1.95 per cent., were found to be trichinous. The number of trichinous hogs, however, varied in different localities between 0.28 and 16.3 per cent. According to a note in the Berliner Tierärztl. Wochenschrift, in 1890, 10 per cent. of the emale hogs and 14.87 per cent. of the male hogs in the city of Boston were found to be trichinous, while on an average from 2 to 3 per cent. of the hogs raised further inland were infested with trichinæ. Finally, among 88 hogs imported from America into Dresden in 1881, 14, or 15.9 per cent., were trichinous.

(*b*) *Demark.*—Krabbe, during the years 1866 to 1892, demonstrated the presence of trichinæ in 36 Danish herds of hogs. In Hamburg, 26 trichinous hogs of Danish origin were found in 1886, 23 in 1887 and 15 in 1895. Moreover, in 1895 trichinæ were repeatedly found in pieces of Danish pork, especially in loin roasts and hog necks in Hamburg and other German cities.

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* For an account of the controversy concerning trichinæ in American pork, see Stiles, Trichinosis in Germany, Bureau of Animal Industry, Bul. 30.—Translator.

(*c*) *Austria-Hungary.*—The reports on meat inspection for the Kingdom of Saxony contain interesting data concerning the occurrences of trichinæ in Austrian and Hungarian hogs. Among Austrian and Hungarian fat hogs the following numbers were found trichinous: in 1892, 11; in 1893, 9; in 1894, 9.

In 1895, 0.024 per cent. of the hogs introduced from Hungary into Saxony were found trichinous. Moreover, trichinæ have frequently been demonstrated in Saxony in hams and salamiwurst of Austrian origin.

(*d*) *Russia.*—According to Nebykow, 0.25 per cent. of the hogs inspected in St. Petersburg in 1882 were trichinous and .12 of those inspected in 1883. In Moscow the frequency of trichinosis in hogs varied during the years 1889 and 1892 between .07 and .17 per cent. In Kharkov in 1875, .12 per cent. of the inspected hogs were found to be trichinous, and in Kalisch, according to Fedecki, during the years 1882 to 1885, .16 per cent. were trichinous.

(*e*) *Sweden.*—Among 35,987 hogs examined in Stockholm, 42 were infested with trichinæ. Moreover, trichinæ have been repeatedly found in Hamburg in pork imported from Sweden.

The occurrence of trichinæ in foreign countries is also demonstrated by trichinosis, which is observed in the majority of the European countries, especially Belgium,* Denmark,† England, France,‡ Holland, Italy, Spain, Austria,§ Russia,|| Sweden, the former Danube principalities, also in North and South America, Egypt, Algiers, East Africa, Syria,¶ India and Australia.

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* In Herstal, near Lüttich, 47 persons were seriously affected with trichinosis in 1893 and 12 died.

† Friis collected 27 cases of trichinosis in man in Denmark with a fatal attack in two cases.

‡ In 1878 a small epidemic of trichinosis was observed in France (Braun).

§ In Teplitz, in 1894, 63 persons were affected with trichinosis and 50 persons during the same year in Freudenthal. Moreover, during 1894 the report showed the affection of 31 persons with trichinosis in Bohemia with a fatal attack in 12 cases. In 1897 a small, but, nevertheless, serious, epidemic of trichinosis occurred in Brüx and a more extensive one with a fatal attack in 5 cases in Iglau.

|| During the years 1889 to 1891, in the governmental district of Bromberg, 11 persons were affected with trichinosis, after eating unsmoked sausage from Russian Poland. In 1895 an outbreak of trichinosis occurred in Opatow from eating Russian meat.

¶ On account of the occurrence of trichinous hogs in Syria, the Italian Government has prohibited the introduction of hogs and pork from the Ottoman Empire.

Can Sucking Pigs be Infested with Trichinæ?—In countries which have introduced obligatory inspection for trichinæ, sucking pigs, as a rule, are also subjected to compulsory inspection for this parasite. Protests against such inspection have repeatedly been made by interested parties, accompanied by the statement that trichinæ do not occur in sucking pigs.

The experiments of Gerlach throw light on this question. Gerlach demonstrated that trichinæ are not congenital. Two female rabbits which Gerlach had fed on trichinous meat gave birth to young twenty-two and twenty-eight days after infection. The young animals were free from trichinæ in spite of the fact that large numbers of freshly migrated trichinæ were found in the mothers. On the other hand, Gerlach found that pigs may become infested with trichinæ at a very early age. He placed two eight-weeks-old pigs with an old hog which had previously been infested with trichinæ and which within a period of several days had been fed twice, each time outside of the stall, with trichinous meat. Both pigs were killed five weeks after the second feeding of the old hog. It was found that one was slightly infested with muscle trichinæ. Probably the pig had ingested trichinæ which had been expelled in the feces of the old hog along with undigested pieces of muscle.

But, even if we disregard these experiments of Gerlach, compulsory inspection of sucking pigs is justified, because the ingestion of trichinous material may take place by some accident or other soon after birth and the development of trichinæ capable of infesting other hogs may take place in pigs which are only a few weeks old; for muscle trichinæ are capable of transmission when they reach the size of 0.5 to 0.75 mm., or within 16 to 20 days after the ingestion of trichinous material (page 479).

Frequency of Trichinæ in Dogs.—Among 1,167 dogs slaughtered in Chemnitz during the four years 1897–1900, 13, or 1.11 per cent., were infested with trichinæ (Tempel).

Extensive and Slight and Repeated Invasions.—Trichinæ may occur so sparingly in the body of the hog that even several dozen microscopic preparations from the most frequent seat of trichinæ will disclose only a single parasite. On the other hand, hogs have been found in the practice of meat inspection which were completely permeated with trichinæ.

As a rule, the trichinæ in hogs spontaneously infested are all in the same stage of development, which points toward the single

ingestion of trichinous material. There are exceptions to this usual finding, in which, on account of the various developmental stages of the trichinæ, it is necessary to assume repeated invasions.

The following statistics from the city meat inspection in Berlin may serve to illustrate the above-mentioned conditions:

Year	*Trichinous hogs*	*Extensively infested*	*Moderately infested*	*Slightly infested*
1889–90	292	101	81	110
1891–2	254	67	85	102
1893–4	122	39	34	49
1894–5	136	63	27	46
1895–6	158	49	41	68
1896–7	192	108	22	62

Among the hogs which were only slightly infested, there were always several in which, despite extensive investigation, only a single trichina could be found.

Of the 192 trichinous hogs reported in the year 1896–7, 171 showed living trichinæ only, 13 a few calcified trichinæ, and 8 both living and calcified trichinæ.

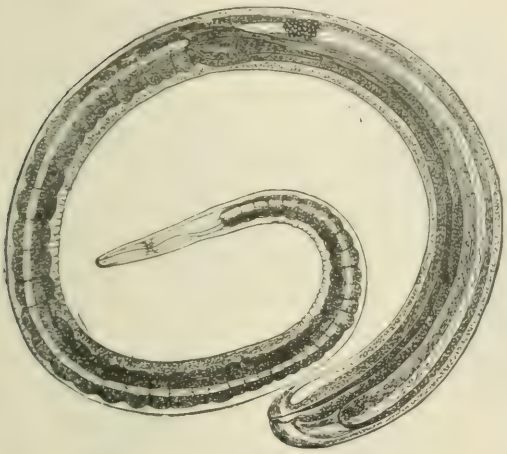
The Number of Trichinæ in Badly Infested Hogs.—According to Leuckart, trichinæ are frequently found to the extent of 1,500 per gram of muscle. Schreyer counted the trichinæ in one gram of musculature from various parts of the body of the hog and estimated the total number of trichinæ in a hog which weighed 174 pounds (after subtracting 50 per cent. of the weight for fat tissue, bones, tendons, etc.) as 63,162,000. Schumann and Ludwig calculated the number of trichinæ in a similar manner in the case of a badly infested hog (3,961 trichinæ per gram) as 158,400,000.

Diagnosis.—There is no other method for the certain identification of trichinæ than microscopic investigation. A slight magnification, however, is sufficient for this purpose. The proper magnification is 40 diameters. With this magnification one plainly observes the encapsuled muscle trichinæ as lemon-shaped, oval or spherical structures, recognizes the transparent double-contoured wall, the characteristic trichina capsule, and the spirally-coiled or pretzel-shaped worm. With the above-named magnification, the recognition of the migrating and resting, but not coiled, trichinæ is more difficult. However, the granular cloudiness of the muscle fibers in cases of fresh invasion by still uncoiled muscle trichinæ arouses suspicion of the presence of the parasites, which may be

demonstrated with certainty by the use of a stronger magnification.

Franck and Tiemann recommended the examination of preparations by means of hand lenses with a magnification of ten diameters. Experienced inspectors are able to recognize trichinæ in pork, even with this magnification (Fig. 149). A magnification of 40 to 50 diameters, however, at least for less experienced inspectors, is much more reliable. Greater magnifications than 40 to 50 diameters are unnecessary and also unsatisfactory, since the greater the magnification the more time required for examining the slides.

Fig. 148.



Developed muscle trichina after removal from the capsule, with intestine, genital organ and lateral line (Leuckart).

Fig. 149.

Trichinous musculature. × 10 diameters.

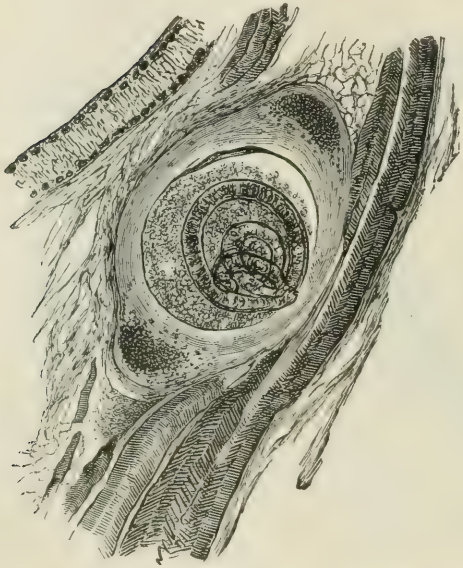
Kafitz recommends projection in the place of direct microscopic examination of trichina preparations. Inspection by means of projection is simpler and more reliable in the case of fresh meat than direct examination. Until further experience is had, it may be recommended at any rate for use in the further examination of samples already inspected.

Calcified trichinæ, as well as the still incompletely developed muscle trichinæ, offer some difficulties in making a reliable diagnosis. Finally, the recognition of trichinæ becomes difficult if it is necessary to demonstrate them not in fresh meat, but in preserved pork, especially smoked hams. For the better recognition of trichinæ in such material, Duncker recommends treating the sam-

ples of muscles for several minutes with dilute acetic acid. In American hams preserved according to the newer methods, in which the trichinæ are only slightly differentiated from the musculature, which becomes transparent during the process of preservation, I have found the addition of water to be advantageous.

Differential Diagnosis.—Without a careful examination, other objects can be easily confused with encapsuled and still uncalcified

Fig. 150.



Encapsuled muscle trichina with incipient polar calcification (Perls). × 130 diameters.

Fig. 151.

Vinegar eel.

trichinæ. Even Miescher's sacs, which are so frequently observed in muscles, have such distinct characters that it is impossible to mistake intact and uncalcified specimens. The same is true of muscle distomes (page 404). With reference to the much more important differentiation of calcified trichinæ from other calcified depositions in the musculature, I must refer to the section on "So-called Calcareous Concretions in the Musculature of Hogs" (page 539 ff.).

Among the accidental kinds of contamination of pork which have already led to confusion with unencapsuled trichinæ, special mention should be made of the vinegar eel, *Anguillula aceti*. This nematode may appear in the preparations if the samples of muscle have been preserved in vinegar or unclean vessels. The vinegar eel is about twice as long and considerably slenderer than the fully developed muscle trichina, and, moreover, is pointed at both ends (Fig. 151). Vinegar eels, moreover, lie between the muscle fibers and, as a rule, exhibit active movements. Wallmann, in a preparation for trichina inspection, found an actively-moving nematode between the muscle fibers, which was pointed at the anterior and posterior ends like the vinegar eel, but was shorter and broader than the latter. George demonstrated a nematode between the muscle fibers in the preparation which could be distinguished from a migrating trichina by the blunt character of the oral end and which possessed great resemblance to an embryo of *Strongylus paradoxus*. Samples for trichina inspection may be easily contaminated by the embryos and eggs of this parasite, after making an incision into the lungs when these organs are infested with *S. paradoxus* (Fig. 152, Tiemann).

Fig. 152.

Eggs and larvæ of Strongylus paradoxus in a preparation for trichina inspection. (From a photograph.) × 35 diameters.

Rhabditides (larvæ of Strongylidæ), according to reports of Leuckart and Zürn, have frequently been mistaken for trichinæ. These undeveloped nematodes live in decomposing substances. The rhabditides are distinguished from trichinæ, aside from their internal anatomy, by the pointed posterior end. Moreover, like the vinegar eel, they likewise lie between muscle fibers.

Merkel found in three instances, in the eye muscles of hogs, nematodes of the length and thickness of female intestinal trichinæ with pointed oral end and sucking disks on the posterior end of the body. These worms, which were not identified more accurately, lay extended between the bundles of muscles.

Among the accidental kinds of contamination, we should doubtless mention also the "*Haplococcus reticulatus*" found by Zopf in 1884, between the muscle fibers in a large number of pork samples and supposedly belonging to the Myxomycetes. According to

Möller, the haplococci of Zopf are nothing more than spores of Lycopodium. Finally, in conserved pork, masses of tyrosin crystals may appear which have likewise been mistaken for trichinæ, especially with the calcified individuals (p. 545).

JUDGMENT.—By eating trichinous pork human beings may contract trichinosis, which, under certain circumstances, is a very serious, if not fatal, disease. The mortality in trichinosis in man varies. It may, however, reach from 10 to 40 per cent. Trichinous pork must, therefore, be considered as a highly dangerous food material.*

Symptoms of Trichinosis in Man.—Trichinosis exhibits two stages. The first is caused by the penetration of the female intestinal trichinæ into the mucous membrane of the intestines and is characterized by symptoms of irritation which vary, according to the number of trichinæ which have been ingested, from a catarrh to an inflammation of the intestines. Patients show a partial or complete loss of appetite, indisposition, pains in the body, diarrhea, and occasionally vomiting. According to Gerlach, a loss of appetite and nausea appear within twelve hours in cases of extensive invasion. The second stage begins, as a rule, after three weeks, but may occur during the second week or not until the fourth week after the ingestion of trichinous meat. This stage is characterized by fever, lassitude, violent muscular pains, pains in the eye, difficulty in swallowing, hoarseness, pains felt in masticating, edema of the eyelids, face (in acute cases), and of the extremities. Recovery begins with the encapsulation of the trichinæ. Strange to say, children are less violently affected than adults (Penkert, Holzhausen).

* For example, extensive epidemics of trichinosis appeared in Hettstädt in 1863 (168 cases, 28 deaths); Hanover, 1864–5 (more than 300 cases); Hedersleben, 1865 (337 cases, 101 deaths); Potsdam, 1866 (164 cases); Greifswald, 1866 (140 cases, 1 death); Magdeburg, 1866 (240 cases, 16 deaths); Halberstadt, 1867 (100 cases, 20 deaths); Stassfurt 1869 (more than 100 cases); Wernigerode, 1873 (100 cases, 1 death); Chemnitz (194 cases, 3 deaths); Linden, 1874 (400 cases, 40 deaths); Niederzwehren, near Kassel, 1877 (one-half of the inhabitants); Diedenhofen, 1877 (99 cases, 10 deaths); Leipzig 1877 (134 cases, 2 deaths); Ermsleben, 1883 (403 cases, 66 deaths); Strenz-Neuendorf, 1884 (86 cases, 12 deaths); Kelbra-Altendorf, 1895 (242 cases, 1 death), etc. Smaller epidemics of trichinosis occurred in Stollberg, 1860; Plauen, 1861–2; Calbe and Magdeburg, 1862; Dessau, 1864; Görlitz, 1865; Erlangen, 1870; Northumberland, 1871; Göttingen, 1871; Stettin, 1877; and Hof, 1878. Johne states that in Saxony during the years 1860 to 1889, not less than 109 epidemics of trichinosis occurred with 3,402 cases and 79 deaths, a mortality of 2.3 per cent.

Symptoms of disease are not observed in trichinous hogs, even when the animals are badly infested (Kühn). Penkert reports concerning the hog which caused the epidemic of trichinosis in Hedersleben that it was in such fine condition that it was exhibited for show purposes.

Not all meat, however, which contains trichinæ is invariably or to the same degree dangerous or injurious to the health of the consumer. Reinhard asserts, on the basis of an interesting calculation, that in the Kingdom of Saxony during the years 1860 1875, more than 900 trichinous hogs were consumed without any striking symptoms of the disease having been produced. During this period there were 39 epidemics of trichinosis in the Kingdom of Saxony with 1,267 cases and 19 deaths. In all, however, during the same period, 6,959,964 hogs were slaughtered, among which, according to the average ratio of 1:7000, nearly 1,000 trichinous hogs must have been found. Not more than 4 out of every 100 trichinous hogs caused trichinosis in man.

The dangerous character of trichinous meat depends (1) on the number of trichinæ present in the meat; (2) on their developmental stage; and (3) on the form in which the meat is eaten.

1. As a rule, according to all experience, isolated trichinæ in pork are incapable of producing genuine trichinosis. Bollinger says that where only a small number of parasites are present, the disease is never serious. On the other hand, Pütz is of the opinion that pork only slightly infested with trichinæ, while not producing epidemics, may, nevertheless, cause serious disease in isolated cases if the meat of a whole hog is gradually consumed by a few persons.

That the invasion of human beings by trichinæ frequently passes by unobserved is shown by the incidental finding of trichinæ in persons who have died of other diseases. Fiedler demonstrated trichinæ in from 2 to 2.5 per cent. of the cadavers in Dresden; Wagner, in from 2 to 3 per cent. of those in Leipzig; Rudnew, in 1.5 to 2 per cent. of those in St. Petersburg; and Turner, in 1 to 2 per cent. of those in Scotland.

2. Transmission to man occurs with certainty only in the case of well-developed muscle trichinæ provided with capsules. Migrating trichinæ are harmless and resting trichinæ are not able to undergo further development in the new host except when the sexual organs are differentiated. This differentiation occurs in resting trichinæ when a body length of from 0.5 to .75 mm. has been reached (Fiedler). It has been shown, however, by feeding experiments, that such muscle trichinæ with non-encapsulated trichinæ

embryos, even when they have reached this size, are in great part digested in the stomach of their new host.

Furthermore, trichinæ which become pathologically encapsuled and calcified (page 465), as a rule disintegrate completely, as contrasted with parasites which are included in normally calcified capsules.

3. The form in which the meat is eaten is of greatest importance in the transmission of trichinæ, for trichinæ which are contained in meat may be killed by external influences and certain methods of preparation. Desiccation kills trichinæ in a short time ; likewise, salting. According to Fürstenberg, pickling for ten days is sufficient to kill trichinæ in small pieces of meat. In larger pieces of meat this result, according to Leuckart, takes place after treatment with salt for four weeks without the addition of water. Gerlach, however, found living parasites along with shrunken specimens in meat which had lain in pickling brine for two months. According to Blasius, trichinæ in thin layers of meat are killed within six weeks by pickling, while in thicker pieces they are not destroyed until after five months. Colin determined that a slight salting does not kill the trichinæ, but that they gradually die under the influence of extensive and complete penetration of the salt. In pieces of meat thoroughly penetrated with salt, the trichinæ near the surface die within fourteen days, while in the deeper-lying parts they are not killed until after from four to six weeks. In sausages the death of trichinæ, even in a weak salt solution, is said to take place within fourteen days on account of the more rapid and complete diffusion of salt. Ordinary smoking, particularly in the case of large pieces of meat, is quite insufficient for killing trichinæ (Fiedler). This explains why so-called smoked sausage and raw hams are rather frequently the cause of trichinosis. Refrigeration, even when applied for a long period and at a low temperature, is absolutely ineffective. Thus, Kühn found that trichinous meat kept in a refrigerator for seven weeks was still infested with living worms. On the other hand, according to Bouley and Gibier, trichinæ in hams died when the hams were subjected to a temperature of —15° to —20° C. An absolutely certain means of killing trichinæ is found in the application of high temperatures. According to Leuckart, trichinæ die at a temperature of 62° to 70° C., since at this temperature their albumen is coagulated. High temperatures, however, penetrate but slowly, and not until after several hours, into the interior of large pieces of meat (see " Boiling and Steam Sterilization "). Trichinous meat can not be regarded as harmless until the

cut surface has assumed a uniformly white or light-gray color, for this coloration is evidence that the meat, even in the central layers, has been heated to a temperature of at least 60 to 70 C.

We must attribute to the influence of desiccation as a result of thorough pickling (injection of brine by means of syringes) the fact that trichinæ contained in American pork are frequently dead, as shown by efforts to revive them and by feeding experiments.

Trichinæ are not killed by decomposition. They have been found alive in decomposing meat after a period of 100 days (Zürn).

The history of trichina epidemics shows that they are caused exclusively by the consumption of raw or partly cooked meat. The majority of these epidemics have occurred in the Province and Kingdom of Saxony, where the consumption of raw or partly broiled meat is a very common custom. In southern Germany, on the other hand, outbreaks of trichinosis are exceedingly rare, although trichinous hogs are brought to market and sold in that region.* The latter is to be assumed as true, since many hogs are sold in the north of Germany for points in southern Germany, and it is, moreover, proved beyond any doubt by the positive finding of trichinæ in several Bavarian cities (for example, Hof and Nürnberg), as a result of the trichina inspection which has been established even for native hogs.† While, therefore, outbreaks of trichinosis as a result of eating pork are rare in Würtemburg, Baden, Alsace-Lorraine and the greater part of Bavaria and Hessen, it is to be ascribed solely to the fact that in these States the consumption of raw meat is unknown.‡ In fact, the custom prevails there of eating all meat

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* Similar conditions prevail in foreign countries. With the exception of northern Germany, there is nowhere in force in the world a general trichina inspection, despite the fact that trichinous hogs occur everywhere (pages 471–472).

† In Nürnberg, during the period 1880 to 1890, 457 hogs were found infested with trichinæ.

‡ Bollinger reports from Bavaria that in that country eight epidemics with ninety-seven cases and four deaths occurred between the years 1853 and 1879. According to Wasserfuhr, during the 80's, thirty isolated cases of trichinosis with two deaths occurred in Bavaria. These cases, however, were restricted exclusively to the three Frankish provinces which border on Saxony, Thüringen and Hessen, and which, in contrast with the rest of Bavaria, have the habit of eating raw or half-cooked meat. An isolated case of trichinosis which recently occurred in Bavaria is very interesting. In Lauf, a butcher was violently affected with trichinosis two days after eating raw pork while making bratwurst. Subsequent investigation showed extensive infestation with trichinæ in the pieces of meat still to be found. Two-thirds of the meat, however, had already been eaten in a cooked condition without causing any harm.

foods in a thoroughly cooked condition. The favorable effect of only a slight degree of heat is shown by the fact that, according to Leuckart, in the epidemics in Hettstädt and Hedersleben, 37 and 43 per cent., respectively, of the persons affected after eating raw meat died, while only 10 per cent. died of those who ate prepared meat. Similar conditions were found by Holzhausen in the epidemic of trichinosis in Strenz-Neuendorf, in which 86 persons were affected and 12 died. The majority of those affected had eaten raw meat, and of the 12 who died, 10 had eaten raw and two partially broiled meat.

Method of Procedure with the Meat of Trichinous Hogs.—In Section 367[7] of the Criminal Law Statutes, which forbids the sale of trichinous meat, is found the fundamental principle of legal regulations that all meat affected with trichinæ, whether the parasites occur sparingly or abundantly, whether they are still undeveloped, fully developed, or already calcified, is to be excluded from the market. The great danger which lies in eating trichinous meat sufficiently explains these legal regulations, especially since the total number of hogs annually found to be trichinous is so small that the hog raisers may easily bear the loss. It has been proposed that pork should be admitted to the market if during an investigation of several dozen preparations the presence of only a few trichinæ was found. It may be objected to this proposition, however, that on account of the great fecundity of female trichinæ the matter can not be considered as ending with the invasion of a single trichina. Furthermore, the cases of hogs which are infested with a single trichina are so rare that an exception in favor of these hogs would be without practical value.

In rendering judgment on calcified trichinæ, it is to be considered that trichinæ which appear to be completely calcified may still be quite capable of producing infestation (page 462).

From a scientific standpoint there would certainly be no objection against admitting to the market partly cooked or steamed meat.

Encapsuled trichinæ have never yet been observed in the viscera. The viscera, however, are treated as "meat" in order to prevent the transmission of trichinæ by means of parts of muscles which may accidentally remain connected with the viscera (for example, portions of the diaphragm attached to the liver).

The intestines of trichinous hogs in case of fresh invasion may contain intestinal trichinæ, and for this reason are to be excluded from the market.

Official Regulations Concerning the Method of Procedure with the Meat of Trichinous Hogs.

(a) *Kingdom of Prussia.*—By a ministerial decree of January 18, 1876, concerning trichinous hogs and meat products, the following utilization of these materials is permitted on the basis of an opinion of the Scientific Deputation for the Medical Service:

1. The skinning and removal of the bristles, as well as the free utilization of the skin and bristles.

2. Simple rendering of the fat and the free use thereof.*

3. The utilization of parts suitable for the preparation of soap or glue.

4. The chemical utilization of the whole body.

(b) *Kingdom of Saxony.*—In the Kingdom of Saxony, in addition to the above-named uses, it is also permitted that the meat of slightly trichinous hogs may be admitted to market under declaration after it has been cooked or thoroughly pickled. The cooking is to be considered as sufficient when it is done either in a steam cooking apparatus in pieces of not more than 5 kg. weight, in such a manner that the interior of the pieces is kept at a temperature of at least 80° C. for a period of 30 minutes, or when pieces of not more than 3 kg. weight are cooked in open kettles for at least 3 hours. The pickling process must be continued for at least 4 weeks.

Trichina Inspection.

States With Trichina Inspection.—In all of the government districts of the Kingdom of Prussia, with the exception of Danzig, Köslin, Stralsund, Schleswig and Hohenzollern; also in the whole Kingdom of Saxony, the Grand Duchies of Mecklenburg-Strelitz, Saxe-Weimar-Eisenach; Duchies Anhalt, Brunswick, Oldenburg, Gotha, Saxe-Meiningen, and in the Principalities of Lippe-Schaumburg, Reuss, Schwarzburg-Rudolstadt and Schwarzburg-Sondershausen, trichina inspection—that is, the microscopic examination of pork—has been introduced as an obligatory measure for the protection of human health. In the Prussian government districts mentioned as exceptions, as well as in the Grand Duchies of Meck-

* The free use of the fat of trichinous hogs, as shown by Schmidt-Mülheim, as well as that of the fat of measly hogs, stands in opposition to the decisions of the Imperial Court of February 3, 1888, and March 25, 1884. The sale of such fat must take place under declaration.

lenburg-Schwerin and in the Principality of Lippe-Detmold, there is only a partial inspection for trichinæ, since the introduction of this inspection is left to the discretion of the various local authorities.

Objections to Inspection for Trichinæ.—From various sides objection has been raised against trichina inspection that this practice is very expensive and that its object is not fully secured, since outbreaks of trichinosis occur in spite of it. In fact, it has been objected that it is highly disadvantageous on the ground that the public remains in a sense of false security and is encouraged in continuing the bad practice of eating raw meat. It is alleged that the only effective precaution would be found in checking that practice by means of official instructions concerning the dangers of eating raw meat. General Physician Wasserfuhr has from the beginning stubbornly fought against the introduction of obligatory trichina inspection and even a few years ago maintained that not a single case was known in which a human being had been affected with trichinosis after eating well-cooked or smoked trichinous pork. He asserted that inspection for trichinæ, which cost Berlin $125,000 annually, was of advantage only to those people who did not observe simple precautions.

Review of the Objections.—It must be admitted that thorough cooking is a satisfactory precaution against trichinosis. This is shown by the example of southern Germany and all other countries in which pork is admitted to the market without previous microscopic examination. It is also to be recommended that the authorities from time to time should call attention to the dangers which may be connected with eating raw meat in spite of the existing meat and trichina inspection.*

* The Royal Police President at Berlin publishes annually the following notice:

"As experience has frequently shown, the public does not yet sufficiently realize that even when a well organized and reliable meat inspection exists for all slaughterhouses in a given locality, nevertheless, partly from places in which meat inspection has been introduced, but is not required for all slaughterhouses, partly from places without meat inspection, and partly also by an evasion of existing regulations, pork not at all or imperfectly inspected may find its way to the market and great danger may thus arise to the life and health of the consumers.

"An earnest warning is therefore issued against the consumption of all raw pork and attention is further called to the fact that a thorough cooking or roasting of pieces of meat and of preparations of pork (meat, blood, and liver sausages, meat croquettes, etc.), is sufficient to destroy the trichinæ which may be present and

On the other hand, however, the authorities have to reckon with a custom which is deeply rooted among the common people and have, therefore, to make sure that in localities where the consumption of raw or insufficiently cooked meat is a common custom, as in most places in northern Germany, trichinous hogs are not allowed on the market, and this can not be accomplished by the cheap advice "help yourself," but only by obligatory examination of all slaughtered hogs.* One must to a certain extent be blind to the truth if he refuses to recognize the good which has been accomplished by the introduction of trichina inspection in the discovery of thousands of trichinous hogs. Since the life of a human being in civilized countries is considered invaluable, it can not be urged as an argument against the practice of this inspection that the identification of a trichinous hog costs on an average several thousand marks.

With regard to the above-mentioned argument against the beneficial action of trichina inspection, Bollinger appropriately remarks: "Even if the objection may be raised against obligatory trichina inspection that it does not protect man with absolute certainty against trichinosis, nevertheless it shares the fate of all other prophylactic hygienic measures, including even the consumption of cooked and fried pork."

It is, unfortunately, an undisputed fact that, despite the existence of trichina inspection, outbreaks of trichinosis occur among human beings. In all these cases, however, it has been shown that it is not the system which is at fault, but merely the practice of it. In all cases, either a gross neglect of duty on the part of the inspector or a fatal error (interchange of samples, substitution of false samples, false stamping, etc.) have been proved. These cases always concerned hogs in which the trichinæ, as shown by subsequent inspection of such parts of the meat as were still to be had, could have been easily demonstrated by giving proper attention to the matter.

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thereby to exclude all danger of injury to health. In order to make possible the thorough cooking of larger, thicker pieces (ham, neck roasts, etc.), it is necessary to make deep incisions at intervals of about 8 cm. into the meat to allow the heat to penetrate sufficiently into the deeper portions of the meat."

* As a warning to those who are opposed to a trichina inspection, the following unfortunate occurrence may be related: In Linden, near Hanover, the microscopic investigation of pork which was introduced in the year 1866, after the great epidemic of trichinosis in Hanover, was allowed to lapse. As a result of this there occurred the epidemic of trichinosis of 1874, in which more than 100 persons were affected and over 40 died.

If the objection is raised to the reliability of trichina inspection that it might easily happen that isolated trichinæ would escape the most careful inspection, the theoretical possibility of such an occurrence must be admitted, but the fact should be emphasized that such isolated trichinæ, according to all our experience, are not capable of producing trichinosis in man. Gerlach has shown that in meat the consumption of which could produce only slight cases of trichinosis, the trichinæ can be detected by an ordinary microscopic examination. Furthermore, in my opinion, the example of Berlin shows most clearly the value of a well organized trichina inspection. A city system of trichina inspection has been in force there for the past twenty years. During this time not only no epidemic of trichinosis has occurred, but not even a single case of trichinosis as a result of eating meat which was inspected in that city; and this, too, although the number of hogs annually slaughtered in Berlin is from 250,000 to more than 750,000 (1883-4, 244,343; 1893-4, 518,073; 1900, 837,057). All cases of trichinosis which have been observed in Berlin during this period are to be ascribed to the consumption of uninspected hams which were sent to consumers from outside sources.*

This experience argues against the assumption of Pütz that cases of trichinosis may occur even under the conscientious practice of trichina inspection, especially when hogs are but slightly infested with trichinæ. Concerning the legal responsibility of the trichina inspector, Pütz says: "If, after repeatedly eating pork, within a short time the persons concerned are affected with trichinosis in varying degrees, but for the most part slightly, it is to be assumed that the hog in question was infested with trichinæ only to such an extent that the failure to detect them in the legally prescribed inspection was possible without any carelessness on the part of the inspector."

Provided the proper selection of meat samples is made, such a failure to detect trichinæ appears to be impossible on the basis of the Berlin experience. To be sure, it should be remembered in this connection that the conditions are somewhat different in Berlin than in a country where in case of slaughtering for home use a cumulative effect may arise much more easily on account of the con-

* In the period just mentioned, the following cases of trichinosis occurred in Berlin after eating pork which was sent directly to the consumers from outside localities: In 1881, 15 cases with 2 deaths; 1882, 3 cases, no death; 1883-5, 10 cases, 2 deaths; 1887, 5 cases, 1 death; 1889, 8 cases, no death; 1893-4, 9 cases, no death.

tinued consumption of the meat of one animal. In doubtful cases, therefore, the judge, according to a principle of criminal process "*in dubio pro reo*," should decide in favor of the defendant.

When properly practiced, trichina inspection must be considered as a measure which perfectly fulfils its purpose.

Practice of Trichina Inspection.—For the proper practice of trichina inspection, the fulfilment of the following conditions is necessary:

1. *Conscientious inspectors*, persons who realize fully their heavy responsibilities, and proper compensation therefor.

One mark (24 cents) may be considered as a suitable fee for inspecting a hog for trichinæ. The inspection of separate pieces is to be compensated accordingly. In order to prevent underbidding, limits should be drawn for inspection districts.

For example, in Sprottau, several trichina inspectors, on account of competition, felt themselves compelled gradually to lower the fees for trichina inspection. Hereupon, the Counsellor of the district issued a decree in the interest of a careful practice of meat inspection, in which he fixed the fee for the inspection of a hog at one mark and at the same time made it a punishable offence to alter this fee. This decree of the Counsellor was approved by the Ober-President with the provision that a variation from the fee as named could be permitted only in case all of the trichina inspectors appointed for a given inspection district should agree upon a uniform increase or a lower fee.

In certain provinces an attempt has been made to stimulate the zeal of trichina inspectors by means of premiums, 10 to 30 marks for a trichina finding. In reality, such an inducement is not necessary, notwithstanding the fact that there is perhaps no less inviting occupation than that of trichina inspector. The offering of premiums may also give occasion to underhand dealing. Thus, in Grünberg, a trichina inspector fed his own and his neighbor's hogs with trichinous meat in order to obtain the premium of 10 marks for each case of infestation discovered by him.

In the Kingdom of Prussia, domestic butchers can not be appointed as trichina inspectors (Ministerial decree of February 18, 1897).

2. *Careful training of the inspectors by the proper experts*, which, in accordance with their course of study, can be found only among veterinarians. For, as Steinbach rightfully asserts, we have to do

with a method of diagnosing an animal disease. In the Kingdom of Saxony, in recognition of this fact, the training and control of trichina inspectors is exclusively in the hands of district veterinarians.* The best opportunities for the training of trichina inspectors are found in abattoirs, since in such places the most abundant demonstration of objective material is possible.

It is impossible to understand why apothecaries should be given authority in ordinances concerning trichina inspection to practice trichina inspection without a previous examination; for information concerning trichinæ does not belong to the subjects of a pharmaceutical course. Müller, in Brunswick, in his *Anweisung zur Untersuchung auf Trichinen*, states, on the basis of certain experiences, that apothecaries which he had previously considered as "born experts" should be subjected to an examination in the same manner as empirics. Only physicians and veterinarians should be exempt from an examination.

Physicians and veterinarians who practice trichina inspection as a profession require a police permit.

3. *The proper selection of muscles to be used in making the examination.*—It has not proved satisfactory to require too many samples. For making an inspection for the presence of trichinæ, the following muscles are the most suitable: The pillars of the diaphragm, the costal portion of the diaphragm, muscles of the tongue and laryngeal muscles; for these muscles regularly contain trichinæ even in the case of slightest infestation, which is not the case in other muscles.†

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*Formerly, in the Kingdom of Prussia, the training and supervision of trichina inspectors was exclusively in the hands of district physicians. Now, however, a change has taken place in so far as in several governmental districts, such as Madgeburg, Oppeln, Posen and Köln, these functions are performed by official physicians and veterinarians in coöperation.

† As already mentioned, page 464, the distribution of trichinæ is by no means uniform. On the contrary, as a result of numerous investigations, we must characterize certain muscles as the preferred locations for trichinæ. For example, Kühn, in three hogs moderately infested with trichinæ, found 25.3 per cent. in the diaphragm, 14 per cent. in the scapular muscles, 11.3 per cent. in the lumbar muscles, 8.5 per cent. in the laryngeal muscles, 7 per cent. in the flexor muscles of the thigh, etc. Kühn demonstrated 1.3 per cent. in one case in the intercostal muscles and in another 22 per cent. Hertwig made a report concerning the enumeration of trichinæ, which was undertaken in samples 10 square centimeters in size from 150 hogs. In all, 1,329 trichinæ were found in the pillars of the diaphragm, 1,115 in the muscles of the tongue, 987 in the costal portion of the diaphragm, 710 in the laryngeal muscles, 491 in the abdominal muscles and 308 in the intercostal muscles. This count discloses at the same time the highly

In taking samples it should always be remembered that the muscles contain the most trichinæ at their points of origin and at the point of transition into tendons (page 460). Moreover, outside of abattoirs, the samples must be taken by the trichina inspectors themselves to prevent substitutions. The stamping of hogs found to be free from trichinæ must also be looked after by the inspectors. In slaughterhouses, the taking of samples and stamping may be suitably done by so-called samplers, and this practice is to be recommended.

In the Kingdom of Saxony, the pillars of the diaphragm, diaphragmatic, intercostal, abdominal, lumbar, or laryngeal and lingual muscles are prescribed. In the Kingdom of Prussia the requirements in this respect vary in different provinces. In most places too many and quite unsuitable samples (for example, even the heart) are named for examination.* In Berlin samples are taken from the pillars of the diaphragm, abdominal, laryngeal and intercostal muscles, with results already mentioned. The intercostal muscles, however, are not suitable for furnishing samples for trichina inspection, since, as a rule, in slaughtered hogs they are strongly infiltrated with fat tissue. Objection may be made against taking the muscles of the eye as samples, as prescribed in many localities, that they are very difficult to dissect out, and objection may be made against samples from other muscles, except those of the diaphragm, tongue and larynx, that they do not belong to the principal locations of trichinæ.

Billings considers it as the most reliable method to examine 24 preparations exclusively from the pillars of the diaphragm. To this practice, which is in vogue in St. Petersburg, no objection can be made (Hertwig).

interesting fact that even in case of very slight invasion, the four first-named muscles regularly contained trichinæ, while they were almost as uniformly wanting in the abdominal and intercostal muscles. The results of the investigation undertaken by Hertwig have been subsequently confirmed by Goltz, Misselwitz, Trautwein and Günther.

In accordance with recommendations made by the writer, the above-named four muscles have been prescribed for microscopic inspection for the presence of trichinæ, in the Prussian governmental districts of Hildesheim, Posen, Magdeburg, Köln, Münster, as well as in the Grand Duchy of Mecklenburg-Schwerin and in the Duchy of Gotha.

* As a model regulation for the practice of trichina inspection, we may recommend the police regulation for the governmental district of Köln concerning the inspection of pork for trichinæ and cysticerci of May 12, 1898 (Ztschr. f. Fleisch u. Milchhyg. VIII.).

Examination of Isolated Pieces of Meat and Meat Preparations.— The examination of 6 suitable preparations each from the pillars of the diaphragm, the costal portion of the diaphragm and the muscles of the larynx and tongue, makes it possible to determine with certainty whether the hog is infested with trichinæ or not. In the investigation of isolated pieces of meat and manufactured articles the certain demonstration of trichinæ which may be present is much more difficult.

Heretofore this difficulty has never been properly appreciated. It has been considered that hams and bacon sides are sufficiently well examined if one, or at most two, samples are taken from them and examined in the ordinary manner. This procedure overlooks the fact that these parts contain trichinæ much more sparingly than the above-mentioned preferred locations of trichinæ. In 1882 Rogner examined various muscles from 21 trichinous hogs for the presence of trichinæ, investigating the preparations of from 22 to 25 square centimeters area from each muscle, and thereby demonstrated the regular occurrence of trichinæ in the muscular portions of the diaphragm, while the parasites were not found in the cervical muscles and muscles of mastication in 6 trichinous hogs, in the hams and abdominal muscles of 9 trichinous hogs and in the intercostal muscles of 10 trichinous hogs.

Goltz took samples from various parts of 26 hogs and made preparations of 30 square centimeters area. In these examinations he found no trichinæ in the abdominal muscles in one hog, in the dorsal muscles of 5 hogs and in the cervical muscles of 3 hogs; only 1 to 4 trichinæ in the abdominal muscles of 11 hogs, in the dorsal muscles of 12 hogs and in the cervical muscles of 10 hogs.

Finally, Günther examined 36 preparations of 30 square centimeters area from various muscles in 50 hogs and found no trichinæ in the hams in 18 hogs, in the abdominal muscles in 18 hogs, in the lumbar muscles in 13 hogs and in the intercostal muscles in 15 hogs, while only 1 to 4 trichinæ were found in the hams of 18 hogs, in the abdominal muscles of 9, in the lumbar muscles of 19 and in the intercostal muscles of 17.

From these counts it appears that the previous customary method of examining hams, sides of bacon and other pieces of meat for trichinæ is unsatisfactory. In making an examination of only 6, or at most 12, preparations from one of these pieces, trichinæ are quite often overlooked, which could have been detected by making a larger number of preparations.

To be sure, it should be admitted that hams and other pieces of meat in which no trichinæ can be demonstrated from 30 ordinary preparations are so slightly infested that their consumption, as a rule, is without danger. With regard to other pieces of meat in which only one trichina is found in 30 preparations, the possibility of danger to human health can not be excluded. It appears, therefore, that as many preparations must be examined from pieces of meat to be inspected as from whole hogs, if the inspection is to furnish a guaranty against trichinæ.

This holds good for hams, shoulders, sides of bacon, backs, loins, spare ribs and necks. Sides of bacon which are perfectly free from muscles do not need to be inspected for trichinæ (Prussian Ministerial Decree, June 21, 1878).

In halves of hogs offered for inspection without larynx and tongue, two samples each are to be inspected from the pillars of the diaphragm and costal portion of the diaphragm.

With regard to manufactured pork products (sausage, etc.), their inspection is to be carried out in such a manner that portions consisting as nearly as possible of muscle are taken from cut surfaces for making preparations. It is, however, a matter of chance if the presence of trichinæ is discovered in this kind of inspection, since, in the commercial preparation of products which are intended exclusively for export, sausage is made from the mingled meat of many hogs. For this reason the inspection of sausage and pressed hogshead furnishes no protection against trichinæ.

4. *Accurate Statement of the Size and Number of the Preparations to be Made from Samples of Muscle.*—In Berlin the custom prevails of inspecting six preparations the size of an oat grain from each of the four muscle samples, which in that city, as already mentioned, are taken from the pillars of the diaphragm and the abdominal, laryngeal and intercostal muscles. The preparations of the size of oat grains are crushed between the plates of a so-called compressorium (Fig. 153), so as to render them perfectly transparent.

5. *Accurate Statement of the Minimum Tissue to be Devoted to the Inspection.*—There is a regulation in Berlin to the effect that, including the making of the preparations, but excluding the taking of the samples, eighteen minutes are to be devoted to the examination of the muscle samples of one hog. In abattoirs this time may be sufficient for the examination of twenty-four preparations made as just described in paragraph 4 preceding. For the examination of more preparations more time is required, and for trichina inspec-

tion in country districts in general, a longer time is to be prescribed. The number of hogs to be inspected by one trichina inspector during a single day should in general not exceed twenty.

The governmental president at Danzig has decreed that trichina inspectors in public abattoirs in which the samples are taken by special samplers may inspect as many as twenty whole or half hogs and shall spend at least fifteen minutes upon each inspection.

6. *Constant or Frequent Supervision of the Trichina Inspectors.*— In order to prevent neglect of duty or carelessness, it is absolutely necessary that inspectors be subjected to some sort of control. The best form of this control consists in the so-called double trichina inspection, in which the same or different preparations from one and the same hog are examined by two inspectors working independently of each other. This system, however, can be practiced only

FIG. 153.

Berlin compressorium for trichina inspection.

in abattoirs. Where it is not practicable, the empirical trichina inspectors are to be subjected as frequently as possible to a control of their work and to visits at regular intervals, in which an examination of the instruments is to be included.* In this control and supervision it is to be remembered that in some cases the failure on the part of the trichina inspectors to perform their duty is not due to carelessness, but to a defect of vision. In the Kingdom of Prussia, the trichina inspectors have to be examined every two years (Ministerial regulations of January 20, 1885). Persons who are admitted to the practice of trichina inspection without an

* If such methods of control as are practiced by the official experts on their official trips were regularly enforced, such occurrences as the epidemic of trichinosis in Strenz-Neuendorf in 1884 would be impossible. The trichina inspector who was responsible for 86 cases of trichinosis and 12 deaths was a habitual drunkard who had made preparations from the hog in question, but had not inspected them, for trichinæ could be easily demonstrated in large numbers in the preparations.

examination are naturally exempt also from subsequent examination.

For the rest, the control and supervision should be practiced by the same experts who make the original examination, with the exception of trichina inspectors appointed in abattoirs, who are naturally under the suitable supervision of the veterinary abattoir directors and may be examined as occasion requires. The same holds true for the confirmation of a finding of trichinæ (page 494).

With regard to better methods of control, Herz makes the following suggestion: It is to be made the duty of trichina inspectors to preserve all preparations inspected by them together with the compressoriums, which may be cheaply made in large quantities from window glass, and to submit them at periods of from two to four weeks to the official veterinarians for inspection together with a record of the inspection report. In order to make it possible to re-examine dissected preparations, it is only necessary to moisten them with salt solution or with glycerine. Kabitz recommended inspection by the projection apparatus for re-examining compressorium specimens which have already been examined under the microscope. This method of making a re-examination is, according to the investigations of the writer, very satisfactory in the case of fresh meat. It requires further investigation to determine whether the projection apparatus can also be used in the case of pickled and smoked meat.

The following case shows the necessity of the control of the instruments. According to the report of the Saxon district veterinarian, Peschel, a trichina inspector in Dresden had to be removed for the reason that he did not observe a single one of twelve trichinæ in a certain preparation. The lenses of the microscope used by this model trichina inspector were smeared with grease and the microscope itself was so covered with dirt that it could be scraped off with a knife.

A single failure to see trichinæ justifies the removal of the inspector (Decision of the Prussian Administrative Court of November 21, 1895).

For further details on the practice of trichina inspection, consult special books concerning this subject (Johne and Long). In this connection we may reiterate that for the practice of trichina inspection a simple microscope with a magnification of 40 diameters and the crushing of preparations between the glass plates of a so-called compressorium, as is customary in Berlin, are especially to be

recommended. Fresh pork is best examined without the addition of water or any other substance. For the examination of hams, on the other hand, the use of water, dilute acetic acid, or potash lye, is desirable.

For preventing erroneous condemnation, it should be required that all findings of trichinæ and all doubtful findings should be submitted for the decision of the supervising expert.

Extent and Results of Trichina Inspection in the Kingdom of Prussia.—An approximate idea of the extent and results of obligatory trichina inspection in the Kingdom of Prussia, as well as interesting data concerning the origin of outbreaks of trichinosis may be obtained from the following statistics :

Year	No. of Hogs Inspected	No. of Trichinous Hogs	No. of Measly Hogs	No. of Trichina Inspectors
1886	4,834,898½	2,114	10,126	22,939
1890	5,590,510	1,756	5,420	24,454
1896	8,759,490	1,877	5 958	27,602
1899	9,230,353	1,021	4,390	28,224

Cases of trichinosis in man were frequently observed during the years 1895 to 1900. From March 7-13, 1885, twelve cases of trichinosis were reported in Wandsbeck on account of eating trichinous meat. These were followed by two in Hamburg and two very slight doubtful cases in Wandsbeck. One of these cases terminated fatally, while all the others were mild. About the middle of August, ten persons living in one neighborhood in Halle, took sick after eating trichinous pork. They were boarding at the same inn and all cases were mild. The responsibility for the matter was never determined.

At the beginning of March, 1877, two cases occurred in Gerdauen, and in January and February, twelve cases with one death in Heilsberg as a result of eating raw meat. Toward the end of March there were eight cases in Mohrungen ; in May, four cases with one death in Ortelsburg, and in February, ten cases in Wehlau as a result of eating insufficiently smoked sausage. In no case was the meat previously inspected for trichinæ. Moreover, toward the end of 1887, five cases of trichinosis with one death in 1888 occurred in Berlin from eating non-inspected pork which had been marketed in the city, and in December, twelve cases occurred in Mühlhausen.

In the year 1888, six cases with two deaths occurred in Fischhausen; in January, three cases in Memel; in February, sixteen cases in Mohrungen. All these cases were due to eating the meat of hogs which had not been inspected. Furthermore, in February, six cases occurred in Mansfeld (the meat was only slightly infested with trichinæ and the inspector was not considered guilty of neglect). In the district of Pinneberg, three cases occurred in December (due to eating raw sausage or imperfectly cooked meat). One child merely had a severe case of diarrhea.

In January, 1889, eight cases of trichinosis with two deaths occurred in the district of Heilsberg after eating raw pork or smoked sausage. The meat was not inspected for trichinæ. Moreover, in January, six cases with one death occurred in the district of Allenstein, and in February, five cases at Burgwenden. In the latter case the meat was eaten continuously for three weeks. Persons who ate only once on the day when the animals were slaughtered remained healthy. Later in February, seven cases with one death occurred in Fischhausen from eating smoked sausage. The meat was not inspected. In September there were about twenty cases in Eisleben, twelve in Wimmelburg and about fifteen in Ahlsdorf, Hergesdorf and other localities, making in all about fifty cases. The cause was not understood. Finally, mention should be made of eight cases in December in the district of Grätz—gross neglect of duty on the part of the inspector—and fourteen cases in seven families during autumn in Halle. In the latter case the cause was not clear.

The majority of cases in the years 1889–1891 occurred in the governmental district Merseburg, where, during 4 successive epidemics, 27 persons were affected. A larger epidemic occurred in the district of Posen with 44 cases and 4 deaths. As a result of these cases 2 meat inspectors in that district were tried and found guilty of gross neglect of duty. In the district of Bromberg, 24 cases were observed and 11 persons were affected as a result of eating dried unsmoked sausage which had been introduced from Russian Poland. These cases caused a proclamation of a police ordinance which prescribes obligatory inspection of pork introduced from Russia. A particularly unfortunate case occurred in Breslau. Although the meat in question had been declared trichinous, it was, nevertheless, sold from a sordid desire for gain. Fourteen persons were affected, 6 of whom died. The vendor of the meat was condemned to 15 years' imprisonment.

Other epidemics of trichinosis occurred in 1890 on an estate

in the district of Schrimm and in Opalenitza, during which 16 persons were affected, all of whom recovered.

In 1891, 7 persons in one family were affected with trichinosis, in the district of Allenstein. All of these persons had eaten of the meat of a slaughtered hog before it had been inspected for trichinæ, which were later found to be present in large numbers. All of the cases terminated in recovery. Likewise in the beginning of 1891, in the district of Ortelsburg, one forester and two dependent families, as well as two other grown persons, were affected with trichinosis. The cases were mild and appeared after eating pork which contained but few trichinæ. The inspector who had not detected the trichinæ was removed from his post. All cases recovered. In Stettin, during the same year, there were 8 cases from eating ham which came from Memel; 6 cases in the district of Grätz, 8 cases in the district of Schrimm, 3 of whom died, and 6 in the district of Schrode, one of whom died. The inspector who had carelessly caused the death of human beings received 6 months' imprisonment.

In the year 1892, 4 cases of trichinosis occurred in the governmental district Königsberg, with a favorable course of the disease; and 22 cases in the governmental district Posen, where 3 deaths occurred in a butcher's family. In 1897, 242 cases with one death occurred in Kelbra-Altendorf. The hogs were slaughtered by "polka butchers," and the meat was probably not inspected, since the trichina inspector did not take samples himself.

In August, 1900, 67 persons were affected with trichinosis in Sangerhausen. This trichina inspector also had not taken the samples himself.

Appendix.

Is inspection for trichina necessary in the case of salted pork imported from America? After attention had already been called to the fact, especially by Virchow, that with the exception of one not unquestionable observation in Bremen,* no case of trichinosis could be ascribed to the consumption of salted American pork, the question of the viability of American trichina has again recently become the subject of the most searching investigation as a result of the admission of American pork (September 3, 1891). America

* According to Röper, 40 persons in Bremen who had eaten only American hams were affected with trichinosis. Another case of trichinosis occurred in Düsseldorf as a result of eating American pork.

had guaranteed the trichina inspection of all pork intended for export. However, the unsatisfactory nature of this guaranty is shown by the extraordinarily numerous findings of trichinæ in American pork which have been made in this country, despite the fact that these products bear the official certificate that they have been inspected according to act of Congress of March 3, 1891. Several authorities, especially Wasserfuhr and C. Fränkel, declared that a subsequent inspection of American pork was unnecessary, since trichinæ which might be contained in the imported products were rendered harmless by the method of preservation and since the best protection against trichinosis is thorough boiling or frying. It was argued that numerous negative results from feeding experiments with American trichinæ demonstrated the slight danger of trichinosis from eating imported products.

Against this line of argument, Hertwig contended that living trichinæ had repeatedly been demonstrated in American pork during subsequent inspection in Germany. Johne had previously emphasized this fact. It was stated that viable parasites were most frequently observed in the interior of meat products. It was held also that boiling and roasting furnish no certain protection, as long as meat was prepared according to the taste of the consumer rather than according to the thermometer. A subsequent inspection of American pork was, therefore, considered necessary. Duncker argued similarly. This author emphasized especially the fact that not only he himself, but other authors as well, for example, in Dresden and Hamburg, had succeeded, by means of feeding American pork to rabbits, in demonstrating the reproductive power of trichinæ in American meat. Similar results were previously obtained by Chattin and Fourment, and recently again by Janssen, Rievel, Böhm and the author. Furthermore, the fact should be emphasized that in a given case no guaranty whatever is furnished of an effective process of pickling which kills trichinæ. It may readily occur that the pickling of certain pieces is incomplete and Hertwig has demonstrated that this does occur. Hertwig repeatedly found American hams which were pickled so defectively that the deeper parts had decomposed. Moreover, it should also be considered that calcified trichinæ are not killed by pickling and that they are sometimes found to be still viable in perfectly pickled products. Finally, the *Deutsche Fleischer Zeitung* called attention to the fact that Section 367 of the German Criminal Law Statutes forbids the sale of meat containing trichinæ and that, therefore, for the traffic it is quite immaterial whether American pork contains

trichinæ in a living or dead condition. Moreover, this journal recounted the fact that American bacon is also utilized in the preparation of mettwurst and cervalatwurst, which, as is well known, are eaten in a raw condition.

What has been said regarding the necessity of inspecting pork imported from America holds true also for pork imported from other foreign countries.

For the older literature concerning trichinæ in American pork, reference should be made to Fränkel (Deutsche Med. Wochenschr., 1891, No. 51). According to more recent experiments, Janssen succeeded in cultivating a few intestinal trichinæ, but no muscle trichinæ, from the specimen of American pork with which he worked. Rievel, Böhm and the author succeeded also in producing a development of muscle trichinæ by feeding experiments with thoroughly dehydrated American ham. On the other hand, Klaphake, Ernst, Fränkel, the Imperial Health Office, Hintzen and Schenck obtained only negative results.

Trichinæ Findings in Imported American Pork Inspected According to the Act of Congress of March 3, 1891.

After the readmission of American pork it was found that pieces of American pork were very frequently trichinous. In these instances it was not a case of slight infestation, but the pieces of pork were frequently so extensively infested with trichinæ that the failure to detect the worms, even by a superficial examination at the point of export, had to be considered as absolutely impossible.

During the subsequent inspection in Germany, trichinæ were found in pork of American origin, as shown by the following statistics:

In Altona, 1891–7, in 63 hams, 2 sides of bacon, 6 pieces of cutlets, and in one large shipment of sausage; in Bremen, 1891–7, in 130 hams, 5 sides of bacon; in Düsseldorf, 1891–7, in 182 hams, 227 sides of bacon, one piece of pickled meat and 6 sausages; in Elberfeld and Barmen, 1891–7, in 114 hams and 9 sides of bacon; in Stettin, in 8 hams and 1,049 sides of bacon; in the Kingdom of Prussia, 1894–5, in 1,624 hams and sides of bacon.

Bockelmann, in Aachen, examined 60 boxes of American sausage and found that 11 contained trichinous products.

That in this regard no change has occurred even at the present time is shown by the fact that in 1899 trichinæ were found in 1,263 hams and sides of bacon of American origin and these findings were

made in pieces of meat in which the parasites could not have been demonstrated if the animals had not been extensively infested.

3.—Parasites Which Are Not Immediately Harmful to Man, But Which May Become So After A Preliminary Change of Host.

Among the parasites of food animals which can not be directly transmitted to man, but only after a previous change of host, belong the echinococci and the larvæ of *Pentastomum taenioides*. The developmental stages of these parasites which occur in food animals are not directly transmissible to man. In fact, human beings may eat organs infested by these parasites without danger to health; nevertheless, it is the duty of the sanitary police to destroy these internal parasites, since they can be transmitted to man by dogs after maturing in this animal.

The echinococcus disease of man, compared with which pentastomatosis plays an unimportant rôle, is a relatively frequent and also a very dangerous disease. According to accurate statistics, one case of echinococcus disease is found in every 130 autopsies in middle Europe. Furthermore, medical experience shows that 50 per cent. of the echinococcus patients die before the lapse of five years. The disease formerly had a very wide distribution in Iceland, where, according to Eschricht, one-sixth and, according to Schleisner, one-seventh of all the inhabitants suffered from it. Finsen and Jonassen, as well as Krabbe (personal communication) consider these figures as too high. According to Finsen, one echinococcus patient is found in each 43 inhabitants of Iceland, and, according to Jonassen, one for every 61. These figures, however, show a very wide distribution of the echinococcus disease on the Danish Island. According to further statistics collected by Finsen, one out of every 27 patients in the nine years from 1857 to 1865 was infested with echinococci.

We have, however, even in Germany, districts in which the echinococcus disease is frequent, especially Mecklenburg and Hither-Pomerania.

The Mecklenburg Medical Society has collected valuable statistics concerning the etiology of the echinococcus disease in that locality. It is shown by the report of Madelung, who summarized the results of this investigation, that since 1850, not less than 182 cases of echinococcus disease in man have been observed in Meck-

lenburg, among which it should be remembered that scarcely one-third were rightly diagnosed. In Mecklenburg, one in 7,108 inhabitants is affected with the disease, and in Rostock, one in 1,414.

According to Madelung, echinococci were found in the various cities of Germany and neighboring countries in autopsies with the following frequency: Rostock, 25 cases, or 2.43 per cent., in 1,026 autopsies; Breslau, 20 cases, or 1.47 per cent., in 1,360 autopsies; Berlin, 33 cases, or 0.76 per cent., in 4,770 autopsies; Göttingen, 3 cases, or 0.46 per cent., in 639 autopsies; Dresden, 7 cases, or 0.34 per cent., in 2,002 autopsies; Vienna, 3 cases, or 0.24 per cent., in 1,229 autopsies; Prag, 3 cases, or 0.23 per cent., in 1,287 autopsies; Basel, Bern and Zürich, 11 cases, or 0.14 per cent., in 7,982 autopsies; Erlangen, 2 cases, or 0.11 per cent., in 1,812 autopsies.

Echinococci in man are rarer in middle and southern than in northern Germany. In northern Germany, the greatest number of cases are observed in Pomerania and Mecklenburg.

Madelung is of the opinion that the frequency of the echinococcus disease in Mecklenburg is not explained by the number of dogs (the ratio of dogs to man is 1 : 18 or 1 : 19; while in Berlin the ratio is 1 : 36; and in Bavaria, 1 : 16 to 1 : 25). It is stated that the reason is to be found in the fact that there is no meat inspection in Mecklenburg.*

The distribution of the echinococcus disease in Hither-Pomerania is similarly explained by statistics collected by Peiper, who, by means of inquiries directed to all physicians and to the heads of hospitals of Hither-Pomerania, succeeded in demonstrating the occurrence of 150 cases of the disease in question between 1860 and 1894. Of these cases, 54 occurred in the Greifswald Pathological Institute. The percentage of echinococcus disease observed in this institute is very high (1.9 per cent.). In Hither-Pomerania, according to Peiper, there is one case of echinococcus disease for every 3,336 inhabitants. In the northern districts of Bergen, Stralsund, Franzburg, Greifswald and Anklam, the disease is more widely distributed (1.2, or 1 : 2,096) than in the southern districts of Demmin, Usedom, Wollin, Ueckermünde and Randow (0.44, or 1 : 7,265). The greatest number of cases occurred in the city of

* Bollinger remarks, with regard to the work of Madelung, that the latter confirms his opinion, elsewhere stated, that the frequency of zooparasitic diseases in man, like that of tapeworms in man, is entirely dependent upon the kind of meat inspection, and that the means for combating these dangerous diseases is found in a better system of meat inspection.

Greifswald (16) and the district of Greifswald (39; = 1 : 1,535); so that we may speak of the endemic appearance of the echinococcus disease in this region. In other parts of Pomerania, echinococcus disease is no more frequent than in the rest of Germany.

According to the investigations of Peiper, the echinococcus disease in man bears a direct relation to the distribution of the disease among domesticated animals. The disease is comparatively frequent among domesticated animals in Hither-Pomerania, where large numbers of domesticated animals are raised. There are 44 cattle, 180 sheep and 40 hogs for each 100 inhabitants, as against 34.5, 41.9 and 20.1, respectively, in the whole German Empire. A very large number of dogs is also kept.

The average percentage of echinococcus disease, according to the results of meat inspection in abattoirs located in 52 different parts of Germany, is 10.39 in cattle, 9.83 in sheep and 6.47 in hogs; while in the abattoirs of Hither-Pomerania, on the other hand (Greifswald, Wolgast, Anklam, Demmin and Swinemünde), it is 37.73, 27.1 and 12.8, respectively; in Greifswald, 64.58, 51.02 and 4.93, respectively.

(a) Echinococci.

Nature.—The echinococcus is the asexual stage of a tapeworm with three to four segments (*Tænia echinococcus* of the dog).

History.—*Tænia echinococcus*, which lives as a parasite in the small intestine of the dog and wolf, was recognized as an independent species of tapeworm by von Siebold in 1853. This tænia is 2.5 to 6 mm. long, 0.3 mm. wide, and furnished with a protruding rostellum and with from 28 to 50 hooks. The last proglottid is about 2 mm. long and contains ripe eggs (Fig. 154). Von Siebold first reared the tænia by feeding the echinococcus to sheep. Leuckart also succeeded in producing the echinococci by feeding ripe echinococcus tænia to a young pig.

Various Forms of the Echinococci.—The echinococci occur in two chief forms: (1) as *Echinococcus polymorphus s. unilocularis* and (2) as *E. multilocularis s. alveolaris*.

E. polymorphus forms simple cysts surrounded by connective tissue. They are of quite uniform appearance in their outer form, but may be distinguished in their internal anatomy by the fact that in some cases daughter cysts, or daughter vesicles, are developed from

the mother cysts; in other cases not. Moreover, the mother cyst, together with the daughter cyst, is a simple structure which is delimited from the neighboring organic tissue by a connective tissue capsule. As contrasted with this form, the multilocular echinococcus forms daughter cysts by constriction, which in turn are furnished with the same reproductive power. *E. multilocularis* develops from a central mother cyst and exhibits an uninterrupted peripheral growth. The second difference consists in the fact that in the case of *E. multilocularis* the daughter cysts do not remain in the mother cyst, or inside of the organic membrane formed about the latter, but, after being constricted off, they become separated from the mother cyst by connective tissue. Consequently, the vesicles in the case of *E. multilocularis* attain no great size and lie in the connective tissue framework like the epithelia of an acinous gland (*E. alveolaris*).

Fig. 154.

Adult Tænia echinococcus cysticus, × 12 diam. (Leuckart).

As a result of the feeding experiments of Mangold, it must be considered as proved that *E. polymorphus* and *E. multilocularis* are not, as was previously assumed, two different growth forms of one and the same species, but are the immature stages of two different, but externally very similar, tæniæ. The chief difference, according to Mangold, lies in the length of the hooks. The total length of the hooks of the multilocular form bears a ratio to that of the hooks of the unilocular species of 18 or 19 to 16; and the

Fig. 155.

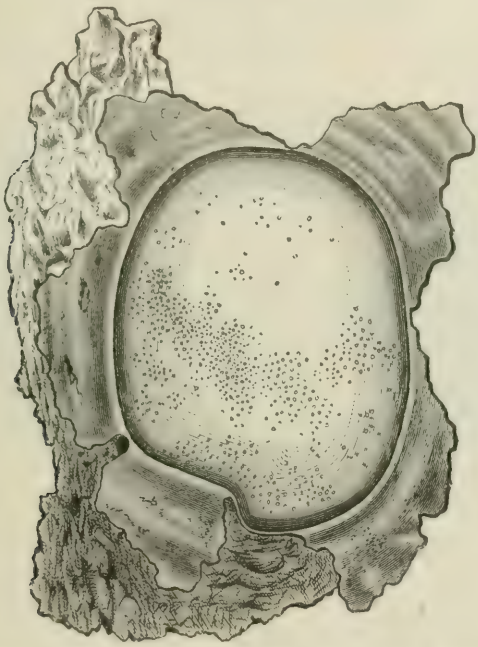
Intact and ruptured brood capsules in their connection with the parenchymatous layer (Leuckart). × 40 diameters.

length of the basal portion bears a ratio of 10 to 7. Moreover, Müller demonstrated that in *T. echinococcus multilocularis* the eggs were grouped together in a conical or spherical mass in the mature proglottid.

Echinococcus Polymorphus S. Unilocularis.

MORPHOLOGY.—*Echinococcus polymorphus* is found in the form of round structures in the interior of various organs. When occupying a superficial position, the parasite appears like a section of a sphere. Two chief portions are to be distinguished in the parasite: the echinococcus membrane filled with fluid and the so-called organic membrane and connective tissue formed by reaction of the surrounding tissue after the invasion of the parasites.

FIG. 156.



Echinococcus polymorphus with brood capsules in natural size and position. (Leuckart.)

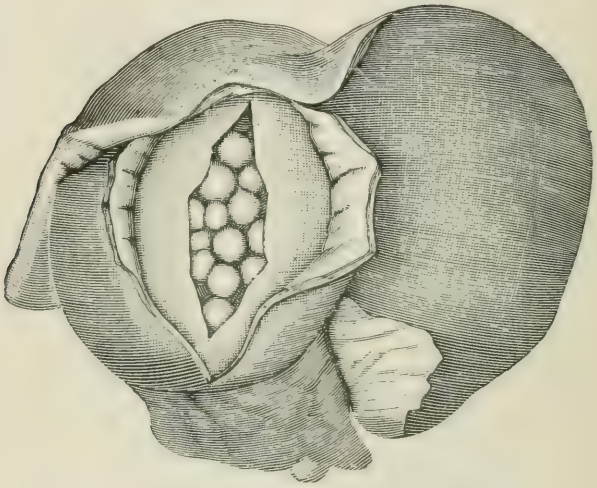
After being removed from the connective tissue capsule, the echinococcus membrane is not of so regular a form as the encysted parasite, but easily becomes wrinkled and corrugated. The color of the echinococcus membrane in the case of young echinococci is light-gray to grayish-blue and pure white in older forms. The membranes of young echinococci are thin and transparent; those of older ones, thick and opaque.

Two layers are to be distinguished in the echinococcus membrane: the striated or lamellate cuticula, and the parenchymatous

layer. The latter has a structure similar to that of the cyst of cysticerci and also possesses calcareous corpuscles (Fig. 163).

The parenchymatous layer may be smooth on the internal surface and may contain only fluid. It is customary, then, to speak of a simple, non-fertile echinococcus (*Echinococcus cysticus sterilus*). This is the form of *Echinococcus polymorphus* which is most frequently observed in all food animals. The parenchymatous layer, however, may produce so-called brood capsules (Fig. 155), which are connected with the parenchymatous layer by short stalks and which contain a variable number of scoleces (*Echinococcus cysticus fertilis*, Fig. 156). This echinococcus form is, as a rule, more rare.

Fig. 157.



Echinococcus hydatidosus of the liver (Thoma).

It is comparatively frequent only in sheep, and less common, on the other hand, in cattle and hogs. Moreover, daughter cysts may be formed from the small remnants of the parenchyma layer which remain lying between the different layers of the cuticula of the mother cyst (Braun). The daughter cysts project either outwardly or inwardly. A portion of them may be dissolved and may fall into the fluid of the mother cyst. Echinococci with outwardly projecting daughter cysts are known as *Echinococcus granulosus*; those with inwardly projecting daughter cysts, as *E. hydatidosus* (Fig. 157). The daughter cysts in turn may form further daughter cysts and may be sterile or fertile.

Echinococcus granulosus is the rarest form of echinococcus in

food animals. The author observed this form in a few cases in sheep. Somewhat more frequent, but still rather rare, is *E. hydatidosus* in cattle, sheep and hogs.

The size of the polymorphous echinococcus varies from that of a sago grain or small pea to that of a man's head. *E. hydatidosus* is usually largest in cattle; in horses, echinococci are rarely larger than a pea.

The youngest forms of echinococci, a knowledge of which is due to the feeding experiments of Leuckart, are distinguished from the older forms by the fact that they do not possess any internal cavity filled with fluid, but appear as solid round structures. These structures have the size of sago grains, are grayish-white or yellowish-white in color and of a gelatinous consistency. Under the microscope we may distinguish a hyaline surrounding membrane and a granulated internal layer in the young echinococci (Fig. 158).

Fig. 158.

Young echinococcus, just out of the capsule, four weeks old (Leuckart). × 50 diameters.

Development of Echinococci. — The development of echinococci takes place very slowly. According to Leuckart, echinococci reach a size of 0.25 to .3 mm. at 4 weeks; 1 to 1.25 mm. at 8 weeks; and 15 to 20 mm. at 20 weeks of age. The central cavity is not to be seen until after 8 weeks and the formation of the brood capsules not until after 5 months.

Occurrence, Location and Pathogenic Importance. — *Echinococcus polymorphus* occurs as a frequent parasite in sheep, cattle and hogs; less often, on the other hand, in goats and horses. The usual locations of polymorphous echinococci are the liver, lungs and spleen; less often, the heart, kidneys, peritoneum, marrow cavities of the bones, lymphatic glands, udder and muscles. The muscles are infested with echinococci only in cases of the most extensive invasion. In exceptional cases even the brain and eyes may be the seat of echinococci (Längrich). It is worthy of mention that in cattle and sheep the lungs are more frequently infested with echinococci than the liver.

As to the pathogenic importance of echinococci, the fact should be emphasized that the general condition and nutrition of affected animals is usually not disturbed even in cases of the most extensive invasion. Cardiac echinococci may, however, produce sudden death; pulmonary echinococci may cause symptoms of dyspnea; hepatic echinococci are usually without effect on the health of the host, even when, as a result of echinococcus invasion, the liver is enlarged 10 to 20 times its normal volume and is so thoroughly infested with echinococci that the parasites lie side by side. This tolerance of the liver toward an invasion of echinococci is to be explained by the slow development of the parasites and the reproductive power of the liver (page 300).

As a result of extensive invasion by echinococci, the liver may reach an unusual volume and an enormous weight. Echinococcus livers have been observed in cattle with a weight of 75 kg. and in hogs with a weight of 36 kg.

The following figures may serve to give some idea of the frequency of the occurrence of the common echinococci: In Berlin during the year 1883–4, infestation with echinococci caused the condemnation of the lungs of 4,085 cattle, 1,896 sheep and 906 hogs; and the livers of 1,164 cattle, 967 sheep and 1,485 hogs in a total number of 93,387 cattle, 78,220 calves, 171,077 sheep and 244,343 hogs. In the year 1888–9, the lungs of 6,578 cattle, 5,041 sheep and 5,010 hogs, as well as the livers of 2,668 cattle, 3,363 sheep, 5,285 hogs were condemned for the same cause in a total number of 141,814 cattle, 115,793 calves, 338,798 sheep and 479,124 hogs. In 1896–7, the lungs of 3,284 cattle, 4,561 sheep, 7,788 hogs, and the livers of 1,156 cattle, 1 calf, 1,939 sheep, 5,398 hogs and 203 various other parts, especially spleens and kidneys, of all kinds of food animals, as well as 2 hog hearts, were condemned for the same cause from a total number of 146,612 cattle, 141,869 calves, 395,769 sheep and 694,170 hogs.

These figures do not give the actual frequency of echinococci, but include only those cases in which, as a result of very extensive invasion, the organs could not be put in a marketable condition by the removal of the parasites.

Mejer in Leipsic found that when isolated echinococci were included, parasites were present in 13 per cent. of sheep and also in 3.75 per cent. of native hogs and 21.47 per cent. of Hungarian hogs. In native hogs the echinococci were more frequent in the livers than in the lungs (3.81 per cent. of the livers as against .26 per cent. of the lungs). On the other hand, in sheep the ratio was

inverted; viz., 12.71 per cent. of the lungs, 3.73 per cent. of the livers. Finally, in Hungarian hogs, 14.79 per cent. of the lungs and 12.3 per cent. of the livers were infested with echinococci.

According to Sahlmann, one-half of the animals in Mecklenburg are infested with echinococci. Metelmann gives the following figures: 25 per cent. of cattle, 15 per cent. of sheep, 5 per cent. of hogs.

Längrich reports the following statistics concerning the frequency of echinococci in animals slaughtered at the Rostock abattoir: In 1895, 37 per cent. of sheep, 26.2 per cent. of cattle, 5.4 per cent. of hogs and 1 per cent. of horses were infested with echinococci, while in 1895–6, 36.8 per cent. of sheep, 26.6 per cent of cattle, 5 per cent. of hogs, 1 per cent. of goats and 1 per cent. of horses were infested, and in 1896–7, 35.2 per cent. of sheep, 26.2 per cent. of cattle, 5.3 per cent. of hogs, 2 per cent. of goats and 1 per cent. of horses were affected.

With regard to the frequency of echinococci in the liver and lungs, Längrich in 1895–6 found the parasites in cattle in from two-thirds to three-fifths of all cases in the lungs and liver, one-sixth to one-fifth of the cases in the lungs and liver only; in sheep the lungs and liver were always simultaneously affected. With hogs the liver was most affected, and in goats the liver, and in horses the lungs and liver were most seriously infested.

In Stettin, Olt calculated the following data from Pomeranian food animals: 293, or 7.1 per cent., in 1,425 cattle; 1,238, or 7.3 per cent., in 16,829 hogs; 3,807, or 25.8 per cent., in 14,717 sheep. Olt also demonstrated the presence of *Tænia echinococcus* in three out of twelve dogs which were inspected in Stettin.

Steuding kept a record of the occurrence of echinococci in the abattoir at Gotha during the months June to August, 1893, and found the following numbers infested with echinococci: 274, or 24.6 per cent., in 1,113 cattle; 633, or 21.4 per cent., in 2,949 hogs; 549, or 35.4 per cent., in 1,551 sheep.

Prettner, in the abattoir at Prag, demonstrated the presence of echinococci in 23.2 per cent. of the cattle and 5.5 per cent. of sheep; in cattle, 14 per cent. of the echinococci were found in the liver, 7.6 per cent. in the lungs and 1.8 per cent. in the liver and lungs simultaneously.

According to Gurin, the frequency of echinococci in the various Russian governments varies in cattle between 0.1 to 80 per cent.; in sheep, between 0.01 and 60 per cent.; in hogs, between 0.01 and 70 per cent.; in horses, between 0.005 and 40 per cent. Among the

3,542 goats slaughtered in an abattoir in central Asia, 14.3 per cent. were infested with echinococci.

Natural Death of Polymorphous Echinococci.—Echinococci, like cysticerci, may die from natural causes in any developmental stage. According to my observations, there are two chief modes of death: coagulation necrosis of the echinococcal membrane and inflammation of the organic membrane. In the first mode of death one observes a shrinking and cloudiness of the echinococcal membrane; later, caseation and calcification. In the second form, on the other hand, one observes fibrinous, or, rarely, even a bloody exudation between the organic and echinococcal membranes, union and adhesion of these two membranes with necrosis of the echinococcal membrane. At the same time, the echinococcus fluid begins to disappear as a result of resorption. In case of coagulation necrosis of the echinococcal membrane, the organic membrane is intact and undergoes but slight alteration in its external appearance, even when the parasites die as a result of inflammation. It is only in sheep that one sometimes observes chondrification and calcification of the organic membranes after the parasites have died.

The disintegrated echinococci present cysts filled with yellow, moist or dry, caseous, purulent or partially or totally calcified contents. Occasionally the caseous content of dead echinococci is of a greenish color.

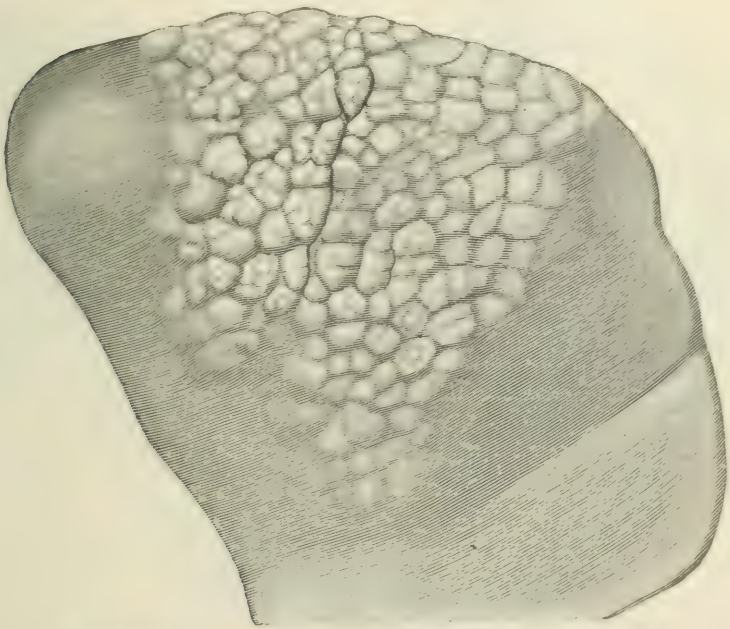
Echinococcus Multilocularis s. Alveolaris.

Occurrence.—This species of echinococcus occurs in food animals, or, more properly, in one of them, the bovine, more frequently than has previously been supposed. The author called attention to this fact in *Deutsche Ztsch. für Tiermedizin, XVII.*, and in that connection described 30 cases which he observed during the course of 13 months. Later, Mejer reported the occurrence of *E. multilocularis* in cattle in Leipsic in 7 per cent. of the total number of cases of echinococcus. According to Gurin, this parasite occurs in 0.2 per cent. of all cattle slaughtered in Russian abattoirs. Moreover, Möbius observed cases in sheep, in the lungs, liver and bronchial glands, and Schmidt, in the lungs. Gurin observed 3 cases of this parasite in sheep. Raillet and Morot reported 100 cases of *E. multilocularis* which were observed in cattle and sheep in the abattoir at Troyes. Among the 200,000 hogs which the author has inspected in the course of several years, *E. multilocularis* was

found only once. Ströse and Gurin have observed other cases in hogs.

Morphology.—In veterinary works the alveolar echinococcus is not well described. According to my observations, the parasite is distinguished by the following characters: *E. multilocularis* forms in the liver, less often in other organs (spleen, lungs, kidneys, lymphatic glands and bones), tumors of various sizes, which usually exhibit a constant growth. These tumors, which resemble specific

Fig. 159.



Echinococcus multilocularis in a beef liver, natural size.

granulations, and are most nearly related to actinomycomata and botryomycomata, exhibit two distinct portions: a central caseified and partly calcified, and an intact peripheral portion. In the peripheral zone, the tumors exhibit an elastic consistency, while in the calcified portion the consistency is tough and soft. The tumor as a whole feels moderately firm. A hard consistency is a rare occurrence and is not caused, as in man, by a great proliferation of connective tissue, but by extensive calcification. A characteristic feature is the rather strong connective tissue framework which

penetrates the whole tumor in a net-like manner and which separates the calcified parts and also the recent cysts from one another. The young cysts arise by evagination and subsequent constriction of the whole wall of the mother cyst. After the young cysts are constricted off, the formation of connective tissue around the cyst takes place.

Distinction Between Echinococcus multilocularis of Man and the Domestic Animals.—The echinococcus of cattle is distinguished from

FIG. 160.

Section through Echinococcus multilocularis of cattle.

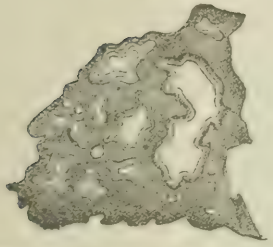
E. multilocularis of man (1) by the fact that it produces no clinical symptoms, but may be unexpectedly found in perfectly healthy animals; (2) by the absence of any considerable local alterations in the surrounding hepatic tissue (no icterus or cirrhosis); (3) by the complete absence of ulcerative processes; (4) by the greater development of separate cysts; (5) by the less extensive development of the connective tissue framework.

In contrast with the alveolar echinococcus of cattle, the case

observed by the author in a hog showed a great similarity with the alveolar echinococcus of man.

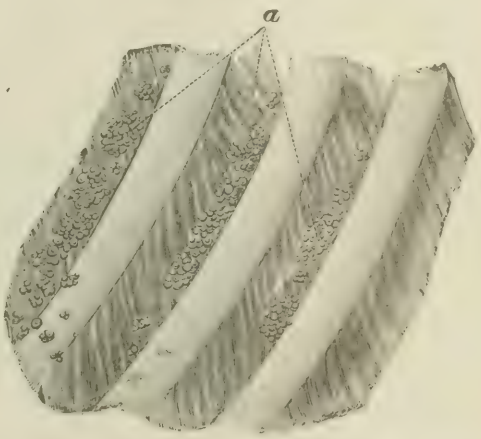
On the costal and pulmonary pleura of the hog in question there were numerous round, lenticular tubercles, as well as roundish and elongated plaques with a granulated surface (Fig. 162). The color of the tubercles was gray or yellow and the consistency hard. The whole condition resembled the pearl disease. Under the microscope, however, it appeared that the tubercles and plaques consisted of a connective tissue framework which inclosed casefied and intact echinococcal cysts. Special mention should be made of the fact that scoleces were present even in the micro-

Fig. 161.



Section through the cortical zone of Echinococcus multilocularis of cattle, × 2 diam.

Fig. 162.



a, Echinococcus multilocularis under the costal pleura of a hog.

scopically invisible cysts. A similar case was recently observed in cattle by Benedictis.

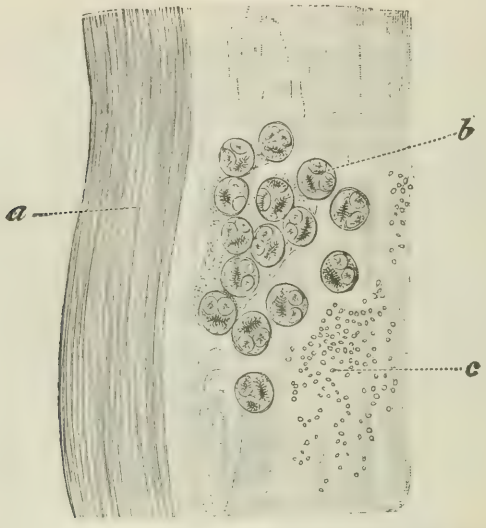
By a careful microscopic examination one observes giant cells immediately surrounding the cysts of the multilocular echinococci, a condition to which attention was first called by Guillebeau in connection with *E. multilocularis* of cattle.

Diagnosis and Differential Diagnosis of Echinococci.—Intact polymorphous echinococci should offer no difficulty in diagnosis if we disregard the above described immature forms. Quite often, however, dead polymorphous and multilocular echinococci are confused with other pathological alterations, especially tuberculosis.

Casefied or calcified polymorphous echinococci, however, are distinguished from tubercles by the integrity of the corresponding lymph glands, the easy separability of the casefied contents from the connective tissue membrane, and the peculiar striated condition of the echinococcal membrane (Fig. 163), which is easily demonstrable, even in the case of extensively casefied echinococci.

E. multilocularis likewise causes, as a rule, no alterations in the corresponding lymph glands and exhibits on the periphery fresh

FIG. 163.



Oblique section through the wall of a fertile echinococcus.
a, lamellate stratification of the cuticula; *b*, scoleces, partly in the brood capsule, partly free as a result of maceration; *c*, calcareous corpuscles. × 35 diam.

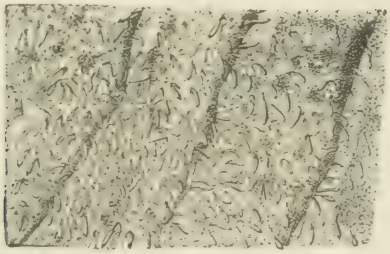
cysts and echinococcal membranes with striated cuticula, at least when examined under the microscope.

Tuberculous conglomerates, to which *E. multilocularis* may show great similarity, possess a firm, dry, or purulent character in contrast with the elastic and tough, but soft, consistency of *E. multilocularis*.

Under certain conditions, unilocular echinococci may give rise to confusion with cysticerci. Lungwitz reported two such cases in which echinococci of the size of peas and located in the heart of a hog were mistaken for cysticerci.

JUDGMENT OF ECHINOCOCCI.—Organs infested with echinococci are not dangerous to health, but are to be considered merely as spoiled (inferior) food material, for the larvæ of echinococcus tænia which occur in the organs of food animals can not develop in man, even if fertile, and do not cause any other harm. The majority of the organs infested with echinococci can be saved for food by carefully removing the echinococci. This is permissible in cases where the echinococci are present only in moderate numbers and of such size that removal is possible. They are best removed by cutting the organs into thin disks. Parasites which are excised during this process and whole organs which are condemned on account of extensive invasion are to be rendered innocuous. Special effort should be made to prevent the possibility of the parasites which have been removed from organs, or of parts which are infested with parasites, becoming accessible to dogs.

FIG. 164.



Intestinal mucous membrane of a dog, with Tænia echinococcus in natural size.

Tænia echinococcus.—*T. echinococcus* develops from the fertile echinococcus of food animals and is parasitic in the intestinal canal of dogs. On account of its small size (Fig. 164), this tapeworm easily escapes observation. We can not, therefore, do otherwise than approve the opinion of the faculty of the Veterinary Institute at Brussels, as handed down, with regard to the admission of dog meat as human food; viz., that the esophagus, stomach and intestines of all slaughtered dogs should be excluded from the market.

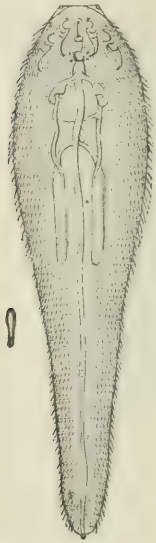
(b) Larvæ of Pentastomum Tænioides.

NATURE AND OCCURRENCE.—*Pentastomum* (*Linguatula*) *tænioides*, Rudolphi, was formerly erroneously classified with the Helminthes, but belongs to the mite-like Arachnoidea, a class of Arthropoda.

The sexually mature parasite is from 8 to 20 mm. long and is found in the nasal and frontal cavities of the dog, wolf, horse, fox, goat and occasionally man; while the larvæ are found in the viscera of cattle, sheep, goats, hogs, deer, hare and rabbits. Only the larvæ of *Pentastomum tænioides* are of importance in meat inspection. These were described by Rudolphi as *P. denticulatum* under the assumption that they were a distinct species.

History.—The occurrence of pentastomes in domestic animals has long been known. Zürn states that *P. tænioides* was discovered

Fig. 165.



Larva of Pentastomum tænioides from a mesenteric gland of a beef animal, × 15 diameters. (In natural size on the left.)

Fig. 166.

Pentastomum tænioides from the nasal cavity of a dog. (Natural size.)

by Chabert in 1757 in the nasal cavities of horses and dogs and that *P. denticulatum* was discovered a few years later by Abilgaard and Fröhlich in the viscera of a goat and hare. It was not until 100 years later, however, that the ontogenetic connection of these two forms was established. It was reserved for the brilliant investigations of Leuckart to demonstrate that *P. denticulatum* was not a distinct species, but merely the larva of *P. tænioides.*

Morphology and Biology.—According to the statements of

Leuckart and Zürn, the larvæ of pentastomum are flat, white, transparent structures, 4.5 to 5 mm. long and 1.2 to 1.3 mm. broad at the widest point. They are divided into about 80 segments which are furnished with numerous backwardly-directed bristles or tooth-like spines. (Rudolphi, therefore, chose the name *denticulatum*). Underneath the mouth opening there are two slit-like apertures on either side, from each of which the points of two claws protrude. (The name *Pentastomum*, "five-mouth," was given from the erroneous interpretation of these slit-like openings). The sexual organs of the larvæ are rudimentary (Fig. 165).

The embryos of *P. tænioides* are provided with a boring apparatus in the form of a stylus-like spine underneath the mouth opening. Moreover, on the opposite end of the body of the tail-bearing embryo, one observes several spines which serve for locomotion. According to Zürn, the embryos bore through the intestinal wall, and, chiefly by means of the circulating blood, migrate under the peritoneum into the liver, mesenteric glands, and, in exceptional cases, even into the lungs, where they become encapsuled and surrounded by a membrane.

Statements concerning the further fate of *P. denticulatum* are at variance. Zürn says that after seven months the parasites become somewhat more active, leave their cysts, and make their way into the body cavity of their host. Here they await an accident to free them "from this prison." If such an accident does not occur, they become encysted again, but only to die. On the other hand, Gerlach, on the basis of a feeding experiment, holds the view that pentastomes do not remain in their host until the death of the latter, but that, after the development of their spines and powerful claws, they change their location and migrate into the lungs and thence into the trachea. Von Rátz agrees with this view conditionally. In a goat which exhibited a cachetic condition, this writer observed numerous pentastomes under the peritoneum and also in the lungs. In the latter organs the worms had bored deeply into the tissue. In another case, a roebuck, the pulmonary pentastomata were partly encapsuled. Babès calls attention to the fact that, in spite of the abundant material which he had occasion to examine, he was unable to observe the migration of the pentastomes described by Gerlach through the lungs and respiratory passages. On the contrary, he found a regular migration of the parasites into the intestines, whence they were carried out by the excrement. Tempel, also, who observed encysted and migrating pentastomum larvæ in the lungs of a goat, argues against the

assumption of a migration of the parasites through the trachea, for the reason that he found the larvæ under the pleura, but not in the trachea, and not in a single instance in the neighborhood of the bronchi.

Distribution.—Concerning the distribution of the larvæ of pentastomum, Zürn states that *P. denticulatum* is found in horses, goats and sheep, more rarely in cattle. Similar statements are made by Pütz and Friedberger and Fröhner. Colin reports from France that during the course of 2½ months he found pentastomes in 300 sheep and 1 dromedary. Two years later, Colin incidentally mentions cattle also as the host of *P. denticulatum*.

Accordingly, in Germany and France, the occurrence of pentastomum larvæ in cattle must be considered as comparatively rare, while Babès made the surprising report from Roumania that he found pentastomum larvæ in all of 20 steers which had died of contagious hemoglobinuria. Babès was inclined to connect this finding directly with the disease, but he soon convinced himself that in Roumania, especially in the swampy low-lands of the Danube, all cattle are extensively infested with pentastomes.

On account of their different economic conditions in Roumania, this statement does not necessarily hold true for Germany. However, at the Central Abattoir in Berlin, I became convinced that even in Germany pentastomes frequently occur in cattle.

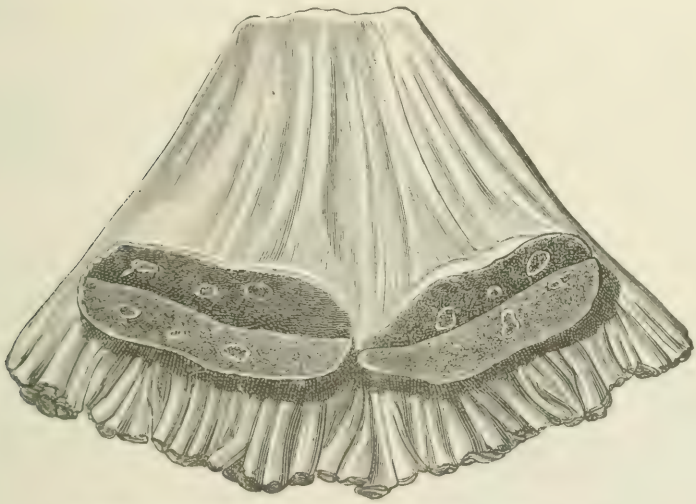
Finally, it should be mentioned that larvæ of pentastomum may occur also in deer and rabbits and have been observed also in two cases in hogs.

Seat of the Larvæ.—According to Zürn, pentastomum larvæ are found under the peritoneum, in the liver, in the mesenteric glands and, exceptionally, also in the lungs. Von Rátz observed them in one of his cases under the peritoneal covering of the liver and in the lungs; in a second case, however, only in the lungs. Tempel was also able to demonstrate the parasites only in the lungs of a goat. Babès, in his numerous cases, discovered the parasites chiefly in the wall of the folds of the small intestines and in the mesenteric glands, but also under the serous covering of the liver and under the pleura. Thirty years ago Colin called attention to the fact that in cases of natural invasion, these parasites are found in the mesenteric glands, while in his feeding experiments with a large amount of material, the liver and lungs were also infested with the worms. The writer has observed pentasto-

mum larvæ, as a rule, in the mesenteric glands and in isolated cases also in the mediastinal, prescapular, iliac, kneefold and lumbar glands, as well as in the liver and spleen.

Pathological Anatomy.—Pentastomes produce various alterations in the mesenteric glands. The most striking alterations are foci of yellowish-green or gray color, varying in size from a millet seed to a pea. They may occur in all parts of the lymphatic glands, but usually lie near the peripheral zone. The smaller foci appear round on cross section. The larger are of a more

Fig. 167.



Bovine mesenteric gland with calcified pentastome foci.

irregular form. The consistency of these structures, which are plainly distinguished from the surrounding tissue of the lymphatic glands, is sometimes that of gruel (in yellow-colored specimens); sometimes more caseous (in case of green color); or, finally, firmer, plaster-like, due to the deposition of lime (in gray-colored specimens).

Under the microscope one observes intact pentastomes in the yellowish and greenish foci, but, in the gray foci, the parasites are cloudy as a result of fatty degeneration and deposition of lime. In the yellowish foci, the worms are surrounded by disintegrated tissue of the lymphatic glands; in the greenish foci, by pus corpuscles; and, in the calcified foci, by detritus and lime deposits. I

have never observed the formation of a capsule in the lymphatic glands, such as regularly occurs in the liver and spleen. Whole worms may be absent in a portion of the gray-colored foci, but characteristic claws are found as the undoubted remains of dead parasites. These claws apparently resist the process of calcification like the hooks of the armed cysticerci.

According to my investigations, bloody foci in the lymphatic glands, such as described by Babès as an almost uniform occurrence around pentastomes, are rare. It is highly probable that these hemorrhages were due to the hemoglobinemia with which the cattle examined by Babès were affected. Even migrating pentastomes which had already bored quite large canals in the lymphatic glands lay, in the case which I observed, in the milk-white or slightly yellow-colored semi-fluid tissue.

In contrast with the pentastomes in the lymphatic glands, those which are found in the liver and lungs are regularly surrounded with blood when the parasites are migrating. Encysted parasites in these organs are white structures, varying in size from a millet seed to a vetch seed.

Diagnosis and Differential Diagnosis.—Old pentastome foci in the lymphatic glands closely resemble tuberculous alterations. When carefully examined, however, there are marked differences between these two conditions. Tubercles are sharply delimited from the surrounding tissue. The most recent tubercles possess a cloudy, casefied center and a transparent periphery; older tubercles, on the other hand, are almost entirely casefied and of a pronounced yellowish color. The consistency is like that of moist or dry cheese. As a rule, fresh tubercles may be observed around the larger tubercles. As contrasted with this condition only yellowish-colored, never deep yellow-colored, foci are found in pentastomatosis. Furthermore, these yellow-colored pentastomes are of a semi-fluid consistency. The pentastome foci, however, which exhibit a more cheesy consistency, are of a greenish color. Finally, partially calcified remains of pentastomes are gray, while tuberculous foci, even in an advanced stage of calcification,

Fig. 168.

Pentastome claws from a strongly calcified focus in a lymphatic gland.

retain their yellow color. Young tubercles with caseñed centers and transparent periphery are not observed in pentastomatosis. Finally, by means of a simple teased preparation, the nature of pentastome foci may be demonstrated beyond question (demonstration of whole larvæ or claws, Fig, 168). In this connection I may remark that, according to my investigations, pentastomes, after migrating, leave smooth cicatrices, but no granules of a tuberculous character.

In distinguishing between pentastomes and tubercles, the intermuscular lymph glands are of special significance, since a false interpretation of tubercle-like pentastomes in these lymphatic glands may lead to an unjust condemnation of whole animals or quarters.

JUDGMENT.—Statistics concerning the frequency of entozoa in dogs furnish a convincing proof that after the introduction of meat inspection in a locality or country, the number of dogs infested with worms diminishes greatly. Deffke demonstrated in Berlin that after the introduction of obligatory meat inspection, tapeworms of dogs became less frequent. For example, according to Deffke, *Tænia marginata*, which was formerly quite frequent in Berlin and which in Iceland infested 75 per cent. of the dogs (Krabbe), and in Saxony, 27 per cent. (Schöne), at the end of the 80's was found in only 7 per cent. of the dogs which were examined. On the other hand, the effect of obligatory meat inspection on pentastomes is not yet observable. Pentastomes are still frequent parasites in the dogs of Berlin. Deffke found them in 13, or 6.5 per cent., out of 200 dogs. No doubt can remain that dogs are the source of pentastome larvæ; for Deffke calls attention to the fact that it is especially the butchers' dogs and dogs used for draft purposes which are infested with *Pentastomum tænioides.*

Through intimate association with dogs, man runs the risk of becoming infected by the ingestion of pentastome eggs. Zenker in Dresden demonstrated the presence of the larvæ of *Pentastomum tænioides* in 4 per cent. of all cadavers which were examined by him. In one case (Laudon) a developed pentastomum was observed in man. Occasionally, also, organs infested with pentastomes may have an injurious effect. As a rule, however, this is not the case, and for this reason organs infested with pentastome foci can not in general be considered as dangerous food material.

In order to prevent further distribution of pentastomes, Zürn recommends "careful examination of food animals in which

Pentastomum denticulatum may be found. If this parasite is found, especially in the livers and mesenteric glands of goats and sheep, or in the peritoneal cavity of rabbits and hare, it should be immediately destroyed, preferably by burning." According to the investigations of the writer, meat inspectors should give especial attention to the mesenteric glands of cattle and sheep. It is a difficult matter to burn all viscera infested with pentastomes. Fortunately, however, this is not absolutely necessary. By far the greater proportion of the mesenteries are rendered in the preparation of tallow and in the manufacture of soap. The possibility of the transmission of pentastome larvæ to dogs is thereby excluded, so that it is only necessary to condemn the more extensively infested mesenteric glands in all cases in which the above mentioned utilization is permitted. This should be practiced in the case of the infected lymphatic glands of poor mesenteries which are not rendered out.

APPENDIX.

1.—Protozoa.

In the skeletal musculature, esophagus, mucous membranes of the stomach and intestines, as well as in the liver of our food animals, various parasites occur which belong to the lowest known animal forms, Protozoa, and which were formerly quite generally characterized as Gregarinidæ, or psorosperms. These names, however, are not in accordance with zoological nomenclature.

According to zoological classification, the parasites in question belong to the second subdivision of Protozoa, or Sporozoa. Under this name Leuckart, in 1879, included a number of unrelated unicellular parasites which form spores with shells. According to Braun, Sporozoa are divided into several orders, of which the following are of importance for meat inspection: Coccidia, Myxosporidia, Sarcosporidia and Hematosporidia.

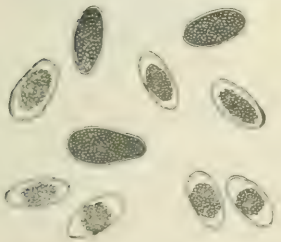
Sarcosporidia and Hematosporidia are the most important orders for meat inspection. The Coccidia play a much less important rôle in food animals, and the Myxosporidia occur only in fish and lower animals.

(a) Coccidia.

The Coccidia are parasites of epithelia. They are small, spherical or oval structures, which destroy the epithelial cells by their rapid growth and then divide into a number of parts. These penetrate into the intact epithelia of the infested organ (*merozoites*) or become changed into microgametes and macrogametes (male and female sexual cells). By the copulation of these forms, sporoblasts are produced and, finally, permanent forms with shells (*sporozoites*) arise. The latter cause infestation of new hosts. The following forms belong to the Coccidia :

1. Coccidium Oviforme (*Leuckart*). — The sporoblasts are elongated, oval and surrounded by a double membrane ; length, 0.03

Fig. 169.



Sporoblasts of Coccidium oviforme from a rabbit liver.

Fig. 170

Rabbit liver with coccidial foci.

to .04 mm.; width, .015 to .028 mm. At first, the protoplasm fills the whole inside of the parasites with a coarsely granular mass, but soon becomes contracted into a sphere from which four sporozoites arise.

C. oviforme is found in rabbits in the epithelium of the bile duct and produces coccidiosis of the rabbit liver. Occasionally coccidiosis of the liver is observed in man.

Coccidiosis of the rabbit liver is characterized macroscopically by the appearance of abscess-like foci which are white in color and roundish in form. Root-like projections are observed on the larger tubercles which correspond to the pathologically-altered bile ducts (Fig. 170). By examination of cross sections it is seen that the abscess-like structures are formed of greatly distended bile ducts,

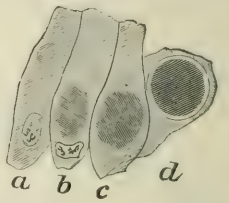
partly fused together, which are sharply delimited from the almost unaltered hepatic tissue by means of fibrous connective tissue and contain immense numbers of coccidia, besides epithelial detritus.

The process begins with the invasion of the coccidia into the epithelia of the bile ducts. The epithelial cells which are attacked by the coccidia are destroyed. Later a marked hyperplasia of the epithelia and a papillary proliferation of the bile ducts arise, so that these structures do not represent simple canals, but much-branched cavities (Fig. 171).

Fig. 171.

Coccidiosis of the rabbit liver. Section through the cortical part of a coccidial focus. Papillary hyperplasia and enlargement of the bile ducts due to localization of the parasites.

Fig. 172.



Red dysentery of cattle. Coccidia in the mucosa of the large intestine. × 1,200 diameters. *b-d*, various developmental stages. At *a* and *b* the cell nucleus is visible. (After Zschokke).

Coccidia in the Liver of Hogs.—Johne described cyst-like cavities with cloudy, chocolate-colored fluid contents in the liver of a hog and was able to demonstrate coccidia in them. I have also found these foci quite frequently in the liver of hogs and can corroborate the statements of Johne on this point. As a rule, we find isolated tubercles varying in size from a pea to a walnut, with tough connective tissue walls and pronounced radiate cirrhosis in the surrounding tissue. Occasionally, however, the whole liver is permeated with such tubercles and the tissue becomes cirrhotic *in toto*. The inner surface of the wall of the cyst shows evaginations and the above-described discolored and rather scanty contents

always exhibit unicellular sporozoa, but in small numbers. Johne leaves the question unsettled whether these structures are identical with *Coccidium oviforme* or not.

2. Coccidium Perforans (*Leuckart*).—The sporoblasts of *C. perforans* are smaller and more spherical than those of *C. oviforme* (0.017 to .024 mm. long and .012 to .014 mm. wide). According to Rieck, they are distinguished from those of the latter chiefly by the fact that in the division of the protoplasm to form the four sporozoites a portion of it remains as the "residual division corpuscle."

Coccidium perforans is found in the intestinal epithelia of rabbits and produces a desquamative catarrh of the whole intestinal tract characterized by a profuse diarrhea. Moreover, *C. perforans* or a related species occurs in the intestinal epithelium of sheep and calves.

Red Dysentery of Cattle.—In the Swiss Cantons, Lucerne and Bern, a peculiar disease of an epizootic nature occurs in cattle, especially in young stall-fed animals, which has been described by Zschokke as "red dysentery" ("dysenteria hemorrhagica coccidiosa," Hess). This name was chosen on account of the constant bloody discharges observed in this disease. In the epithelium of the granulated or longitudinally folded mucous membrane of the colon in the animals, Zschokke demonstrated spherical or oval coccidia, or 0.01 to .22 mm. in diameter. They were homogenous and strongly refractive and with a double contour. After staining with anilin stains, nuclei may be demonstrated which may be three times as large as those of the epithelial cells. The finding of Zschokke has been confirmed by Hess and Guillebeau. Guillebeau is of the opinion that the coccidium of red dysentery is *C. oviforme*.

Judgment.—Zschokke and Hess call attention to the fact that the meat of animals subjected to emergency slaughter on account of red dysentery is always admitted to the market and is eaten without any bad results. The meat, however, possesses the character of a spoiled (inferior) food material and is, therefore, to be sold under declaration.

C. tenellum occurs in fowls and may produce an epizootic, croupous, diphtheritic enteritis, during which, according to Rieck, small disintegration foci caused by invasion of coccidia appear in the mesenteric glands.

Chicken Pox.—"Chicken pox" is a disease of the mucous membrane of the head and neck and of the general integument of fowls, and is characterized by the formation of tubercles. The disease begins with a catarrh of the mucous membrane of the head in the further course of which wart-like proliferations appear on the mucous membrane. The pathological processes spread from the mucous membrane of the head to the skin, on which, especially on the unfeathered areas, miliary to bean-sized neomorphs are formed (epithelioma contagiosum, Bollinger). The dermal epitheliomata are at first gray, often shining like mother-of-pearl, firm, and furnished with a smooth surface. Later they become covered with a scab. Rivolta and Silvestri consider coccidia to be the cause of this readily transmissible epizootic disease. In the proliferating epithelial cells strongly refractive homogeneous corpuscles are observed which stain yellow with picrocarmine and are thereby readily distinguished from the epithelial cells, which stain brownish red. Croupous, diphtheritic deposits may arise on the proliferating portions of the mucous membrane (gregarious form of avian diphtheria, according to Friedberger and Fröhner). The disease may become so extensive on the mucous membrane of the head that the animals are no longer able to close the beak, take nourishment or breathe. According to more recent investigations, "chicken pox" is said to be due to bacteria.

"Chicken pox" is a local disease of certain parts of the head and neck and has no effect upon the food qualities of the other parts of the animal. The customary removal of the head and neck, together with the trachea and esophagus, is sufficient to permit the admission of the animals to market without any restriction. The carcasses of fowls affected with epitheliomata are to be excluded from the market as highly spoiled (unfit) food material only in cases where symptoms of general disease have appeared as a result of mechanical hindrances to the ingestion of food or respiration. Pigeons affected with epitheliomata distributed over the whole body are to be judged in the same manner.

Coccidia in the Fourth Stomach and Intestines of Sheep.—Maske demonstrated coccidia very frequently (in 70 per cent. of the inspected stomachs) in the epithelium of the mucous membrane of the fourth stomach of sheep, especially in the depths of the folds of the mucous membrane. The sporoblasts of these coccidia are comparatively large and are surrounded with a double contoured,

strongly refractive capsule. The coccidia caused tubercles of the size of a pinhead.

For SPIRIDENITIS COCCIDIOSA (granular eruption of hogs), compare page 270.

(b) Myxosporidia.

Myxosporidia are parasitic chiefly in fish. A large number of species are known. Myxosporidia are usually surrounded with a tough cuticula, and contain numerous nuclei. The size varies from microscopic smallness to the volume of a hazel nut. The location is sometimes free in the body cavities, sometimes in the viscera, gills, muscles and dermal epithelium.

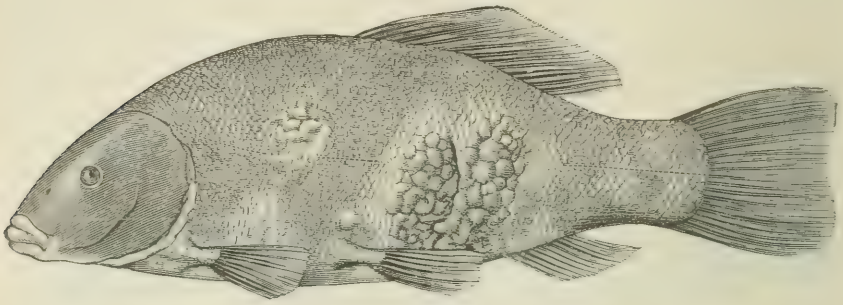
FIG. 173.

Barbel with myxosporidial tumors due to Myxobolus pfeifferi (Doflein).

Among the numerous species of myxosporidia, the most interesting one for us is *Myxobolus pfeifferi*, which may produce the epizootic death of barbel. An epizootic myxosporidiosis of the barbel was first observed in the Mosel in 1870, whence it spread to the Maas, Meurte, Rhine, Marne and Seine. In 1890, Ludwig Pfeiffer investigated the disease which had broken out in this region and found myxosporidia in the muscles of diseased barbel. The affected fish were sluggish, scarcely able to swim against the current, and exhibited discolored swellings of the skin (Fig. 173) and crater-like ulcers on the head, body and tail. Immense numbers of the myxosporidia were found in the ulcers, their primary location being in the muscle cells. Pfeiffer found the other organs of barbel to be free from myxosporidia, while, in the tench, the gall bladder, swimming bladder, spleen and arteries were affected. The pathologico-anatomical processes in an invasion of myxosporidia in

barbels were carefully studied by Thélohan. According to his investigations, the invasion of myxosporidia causes a hyaline degeneration of the muscle fibers, which become disintegrated and are replaced by connective tissue. Thus it comes about that finally one finds the spores of the myxosporidia surrounded by fibrous cysts. The frequently observed eruption of tumors on the body of barbels and the evacuation of a pus-like spore-containing mass is due to the secondary localization of a large bacterial organism described by L. Pfeiffer, which finds favorable conditions for its development in the degenerated muscle tissue of barbels affected with myxosporidia. The bacterial organism in question appears to possess pathogenic properties.

Fig. 174.



Tench with "skin pox."

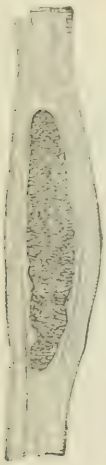
Myxobolus cyprini occurs in the kidneys of carp and tench. In affected fish, white cartilaginous thickenings of epidermis ("pox marks") occur, in which, however, strange to say, no organisms are found (Hofer and Doflein).

Judgment of Coccidia and Myxosporidia.—Nothing is yet known concerning the injurious effect of eating organs which are infested with coccidia and myxosporidia. Practically no careful investigations have been made on this subject, and until this question is settled, we must exclude from the market all organs affected with coccidia and myxosporidia. This method of procedure is justified by the alterations which extensive invasions produce in affected parts. In the myxosporidial disease of the barbel, we should also remember that even uninfested parts of the diseased fish are discolored yellow, are of a gelatinous consistency and assume a more or less conspicuous bitter taste on cooking.

(c) Sarcosporidia.

General Characters.—In 1884 Balbiani characterized as sarcosporidia the parasites which had previously been known under the name of Miescher's sacs in the musculature of warm-blooded animals. Sarcosporidia are elongated or oval structures which have their seat either in the muscle fibers (Miescheridæ), or in the connective tissue (Balbianidæ). Some of the former are surrounded by a thin structureless membrane (Miescheria); others possess a thick membrane provided with transverse striæ or bristles (Sarcocystis, Blanchard).

Fig. 175.



Meischer's sac from the musculature of a hog. × 30 diameters.

Fig. 176.

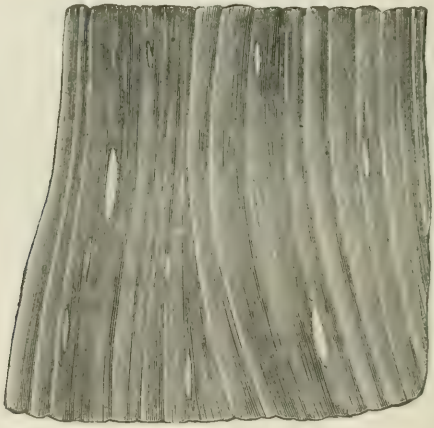
End of a Miescher's sac with contents. At the side, sporozoites greatly magnified. (Leuckart.)

According to Bertram, whose brilliant investigations contributed greatly to a better knowledge of the sarcosporidia, one finds the youngest forms as small sacs consisting of a surrounding membrane, and round or oval cells. From these the sporoblast mother cells are formed and from the latter in turn the sporoblasts. In the meantime the surrounding membrane becomes two-layered. From its inner layer a supporting substance develops around the sporoblasts and also the cells which are later formed from the layer out of which arise the sporozoites, formerly known as sickle-shaped corpuscles. The whole sac is thereby divided into a system of chambers which contain sporozoites in the form of balls.

According to Braun, the sporozoites of sarcosporidia are very small, apparently membraneless corpuscles, with a nucleus, and often with one or two transparent spots. The form is elongated, C-shaped, or fusiform and clavate (Fig. 176).

The function of the sarcosporidia is completed with the formation of the sporozoites. They may then disintegrate, while, as assumed by Bertram, the sporozoites become disintegrated in the central chambers. So long as the surrounding membrane is uninjured, the cyst persists, and in its chambers a granular detritus is found, together with a few sporozoites which are still preserved. If the necrotic process attacks also the surrounding membrane, leucocytes may apparently penetrate into the sac. Finally, the sacs may calcify.

Fig. 177.



Sarcosporidia from the abdominal musculature of a sheep. Natural size.

To the Miescheridæ belong Miescher's sacs, so widely distributed in the musculature of herbivorous and omnivorous animals. These are observed most frequently in the skeletal musculature of hogs and sheep; also in horses, cattle, goats, deer, dogs, hare and chickens. Miescher's sacs become located inside the striated muscle fibers in their long axis. The elongated smaller specimens exhibit throughout the surrounding tissue a layer of striated substance of varying thickness (Fig. 175). In the case of larger specimens, on the other hand, the striated substance disappears as far as the distended sarcolemma. The size varies. Bertram observed Miescher's sacs which were only 0.04 mm. long

and .006 mm. wide. When fully developed, they are 0.5 to 3 mm. long and of various widths up to 0.4 mm.

Special Features in Various Food Animals.—Miescher's sacs (*Sarcocystis Miescheriana*, Kühn) are quite regularly found incidentally during the microscopic inspection of pork. Kühn found these parasites in 98 per cent. of the hogs which he inspected. When Miescher's sacs are completely or even partially calcified, they may be detected with the naked eye. Calcification begins in the middle of the sac in the form of irregular masses of lime deposits, which, from their reaction to acids, must be considered as consisting principally of calcium carbonate. Occasionally delicately twisted and coiled lime deposits are observed in Miescher's sacs resembling the appearance of primarily calcified trichinæ. In cases of total calcification, Miescher's sacs, when examined macroscopically, appear to be white, but under the microscope they appear as dark, almost black, structures. Calcified Miescher's sacs form one kind of so-called calcareous concretions in the musculature of hogs.

With regard to the seat of Miescher's sacs in hogs, it should be stated that they may occur in all striated muscles, in the myocardium as well as in the skeletal muscles. As a rule, however, in hogs, the abdominal muscles and muscular portion of the diaphragm appear to be more extensively infested than the other muscles.

In sheep, Miescher's sacs reach a larger size than in hogs (Fig. 177). Quite frequently one observes sacs which show a length of 1½ cm. and a maximum width of 0.3 mm.* In the sheep also sarcosporidia appear to be almost uniformly present. At any rate Bertram observed them in Rostock in 182 out of 185 sheep inspected at that place. One observes macroscopically-visible parasites in the dermal and abdominal muscles, as should be stated in opposition to the assertion of Bertram, according to which the larger sarcosporidial forms are found in sheep only in the muscles of the tongue, esophagus, pharynx and larynx. According to Bertram, macroscopically-visible forms may be demonstrated in the muscles of the head and neck and in the intercostal, diaphragmatic, abdominal and lumbar muscles, as well as in the heart.

In horses, macroscopically-visible Miescher's sacs appear most commonly in the musculature of the esophagus and neck. With

* The largest sarcosporidia are found in the fallow deer. Thus, Manz reports sarcosporidia in this animal more than 6 cm. long.

regard to the distribution of Miescher's sacs in the horse, the statement of Siedamgrotzky is interesting, to the effect that he was able to demonstrate these parasites in the majority of horses which he inspected for this purpose in Dresden. Csokor in Vienna inspected 241 horses and found 10 per cent. infested with them.

In cattle, one occasionally observes that the musculature is infested with roundish or elongated foci of a yellowish or dirty ground color, varying in size from a millet seed to a kernel of rye. When examined under the microscope they are found to be Miescher's sacs. These foci may be present in very large numbers in the whole musculature. Sanfelice asserts that he regularly observed sarcosporidia in the tongue of Sicilian cattle.

Pathogenic Importance of Miescher's Sacs.—In isolated cases, which, however, require further explanation, Miescher's sacs are said to have caused inflammatory phenomena in the musculature. On account of their rare occurrence, however, these cases have only a slight importance for us. As a rule, Miescher's sacs heal in the muscle fibers without reaction (Fig. 175).

Rieck described a case in which he assumed the pathogenic action of Miescher's sacs. This case was a beef animal which had exhibited no pathological symptoms during life, but which, after slaughter, presented hard tumors varying in size from that of a fist to that of a child's head in nearly all muscles, especially in the muscles of the abdomen, back, shoulder and thigh. Under the microscope, extensive infiltration of the perimysium internum and externum with small cells was observed in those parts which were affected with the first stages of the disease. In addition to the leucocytes, isolated, membranous, round structures, with a perfectly homogeneous body, were observed in the muscle fibers. In the second stage a chronic interstitial inflammation was present, together with sarcosporidia in the muscle fibers; and in a third stage, a granular disintegration was observed in the muscle fibers infested by sarcosporidia.

A similar case was observed by Pütz in the horse. He, however, left the question undecided whether or not the pathological alterations (interstitial myositis) were due to the presence of the not very numerous Miescher's sacs.

As is well known, Miescher's sacs have also been considered as the cause of the muscle tumors in horses known by the name of "ice balls."

In slaughtering a steer which had shown a stiff gait during life, Tokarenko found the musculature pale-red and exhibiting yellow stripes and spots at certain points. The intermuscular tissue showed a serous infiltration and small hemorrhages were observed in the musculature of the posterior extremities. Microscopic examination demonstrated the presence of an immense number of Miescher's sacs, especially in the muscles of the thigh. The muscle fibrillæ appeared pale; the transverse striation in some parts was totally obliterated, and a granular disintegration had appeared in its place.

Differential Diagnosis. — Intact Miescher's sacs should scarcely give occasion to confusion with other phenomena in the musculature. Nevertheless, calcified sacs in hogs have frequently been mistaken for calcified trichinæ. For the differentiation of calcified trichinæ from calcified Miescher's sacs, see page 540.

Judgment of Sarcosporidia.—From a sanitary police standpoint, sarcosporidia are to be judged somewhat differently than coccidia and myxosporidia. For, in the first place, they produce no striking alterations in the affected organs. Furthermore, it has been proved that sarcosporidia are an exceedingly rare occurrence in the muscles of man. From the fact of their unusual occurrence in food animals, it can not be assumed that sarcosporidia can be transmitted to man by eating meat.

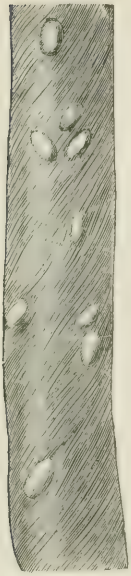
Quite recently, Rosenberg described a case of "undoubted Miescher's sacs" in the heart of a man, and, in this connection, called attention to three cases which were described in 1863 by the Russian scientist, Lindermann. As contrasted, however, with the almost constant occurrence of Miescher's sacs in domestic animals, such cases must be considered as rare.

L. Pfeiffer asserts that feeding experiments with Miescher's sacs in hogs, sheep, dogs and rabbits have given negative results. Moreover, he is of the opinion that muscle infections, analogous to those in hogs, have not been observed with certainty in man. In the cases of alleged sarcosporidial, acute, progressive polymyositis, described by Unverricht, it is stated that neither Miescher's sacs nor the crescent forms were found.

In the practice of meat inspection, it is quite customary to disregard the ordinary slight invasions of Miescher's sacs in hogs and to admit the meat of such animals to market without restriction. This practice is justified so long as the musculature shows no

macroscopically-recognizable alterations, and this is the usual case. Exceptionally, however, the meat must be considered as spoiled (inferior) food material, in case calcification has appeared in many of the Miescher's sacs; and the meat must be considered as highly unfit for food in case the musculature is greatly altered; for example, with yellow or green spots or gray discolorations and watery as a result of extensive invasion of Miescher's sacs. In the last-named cases, the meat loses the quality of human food, for it is exceedingly repulsive and unappetizing. The case is different with hogs in which numerous Miescher's sacs appear as calcareous concretions (Fig. 183). In such cases the meat has, to be sure, lost somewhat in proteid content on account of the lime deposits, but aside from the calcified parasitic foci, the musculature possesses a normal consistency and color, and, as a rule, also an unaltered fat content. For these reasons no objection can be made to the sale of such meat under declaration. If the occurrence of calcified Miescher's sacs is restricted to certain muscle groups, only these muscles are to be treated as spoiled (inferior) food material.

Fig. 178.



Balbianidæ from the esophagus of a sheep.

Sheep in which more or less numerous sarcosporidia of macroscopic size are found in all of the muscle groups, are to be excluded from free sale on account of their inferior quality, and, under certain conditions, are to be absolutely excluded from the market. If, however, the parasites are restricted to certain muscle groups (for example, dermal and abdominal muscles) the meat may be admitted to the market after removal of these parts.

Balbianidæ.—The sarcosporidia which occur so frequently in the interfibrillar tissue of the esophagus in sheep and goats and which in some years are present in almost every individual, belong to the family Balbianidæ. Railliet gave this parasite the name *Balbiania gigantea.** They present white sacs filled with pus-like contents, varying in size from a millet seed to

* Bertram held the opinion that the small sarcosporidia which occur in sheep (*Sarcocystis tenella*, Railliet) and *Balbiania gigantea*, were merely different stages of one and the same species. He believed that at first the parasites were found in the muscle fibers, while later they grew through the sarcolemma and in this manner became transformed into psorosperm sacs.

a hazel nut (psorosperm sacs), which are often found to the number of several dozen in a single esophagus. Morot found them present to the number of 227 in one esophagus. In addition to this location, the Balbianidæ have their seat also in the connective tissue of the lingual and laryngeal musculature, as well as in the thoracic and abdominal muscles.

Judgment.—Formerly the esophagus was not utilized for food. Since, however, it has come to be so used—less scrupulous butchers utilize the "gullet meat" of sheep in the preparation of sausage—it becomes the duty of meat inspectors to condemn all esophagi infested with Balbianidæ and to render them innocuous. By this means also the further distribution of the disease would be correspondingly prevented.

(d) Hematosporidia.

The Hematosporidia, the relationship of which to the Sporozoa is not yet established with certainty, are unicellular parasites of the red blood corpuscles of vertebrates. The first Hematosporidia were observed by Gaule in 1880 in frogs, tritons and turtles. In the same year Laveran made his epoch-making discovery that unicellular motile parasites occur also in the blood of malarial patients. The Hematosporidia acquired importance for veterinary science through the classical investigations of the American author, Theobald Smith, on the subject of Texas fever, in which Hematosporidia were likewise found and demonstrated beyond question to be the cause of the disease.

Texas Fever.—On the subject of Texas fever, we owe to Smith and his co-worker, Kilborne, the following data:

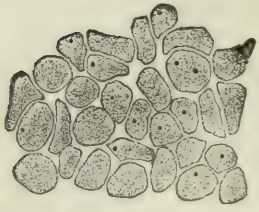
Home of the Disease.—In the southern United States the stationary focus for Texas fever is found in a wide zone extending from the Gulf of Mexico to 37° or 38° north latitude. The native cattle of this region are apparently healthy. If, however, cattle from northern regions mingle with these apparently healthy animals, the former fall ill of the plague. If cattle from the infested territory pass over the northern or southern boundary line, they may carry the disease with them. The incubation stage is about fifty days.

Clinical Symptoms.—The first symptom of the disease is a high fever (40.5° to 42° C.). An acute anemia rapidly follows this stage. Clinical hemoglobinuria is rare. The latter, for the most part, is

demonstrated on post mortem.* The fever persists until death or recovery. At the crisis of the fever, one-eighth to one-sixth of the red blood corpuscles are destroyed within twenty-four hours. After the temperature falls, however, their regeneration takes place rapidly.

Pathologico-anatomical Findings.—Upon making a post-mortem examination one finds red-colored urine in the bladder (hemoglobinuria). The kidneys are dark, brownish-red, or, if the period of hemoglobinuria is passed, they are pale-brown and soft. A bloody edema is observed in the perirenal fat tissue. The spleen is enlarged from two to five times its normal size and is of a dark-red color. The liver is swollen and either filled with blood (in the first stage) or poor in blood and discolored yellowish. Petechiæ under the epicardium and endocardium; bloody erosions on the mucosa of the fourth stomach; in the small intestines, on the other hand, oleaceous deposits which consist of sloughed-off epithelial cells.

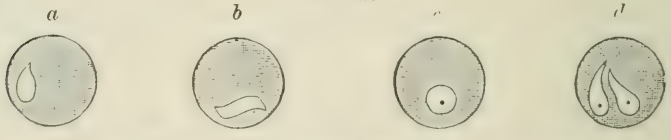
Fig. 179.



Texas fever. Cover glass preparation from the spleen pulp of a beef animal, with quite numerous intraglobular parasites. × 900 diameters. (After Smith.)

Etiology.—As the cause of the disease, Smith discovered protozoan micro-organisms of a pale color and exhibiting amœboid movements at a temperature of 24° C. These organisms live inside

Fig. 180.



Texas fever. Different forms of Piroplasma bigeminum due to amœboid movements. *c* and *d* still possess nuclei; *d* shows the pear-shape characteristic of the acute stage. Much enlarged. (After Smith.)

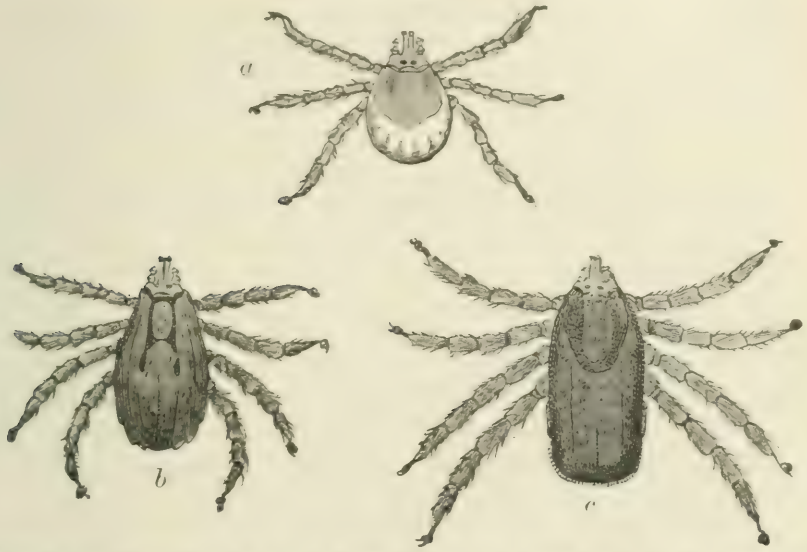
the red blood corpuscles and pass through several developmental phases there. According to Smith, the parasite, called by him *Pyrosoma bigeminum*, is, in mild forms of the disease, small, roundish, coccus-like; in the acute, summer forms, however, it is larger

* This account is based on the investigations of Smith and Kilborne (Bulletin 1, Bureau of Animal Industry, Department of Agriculture). Later investigations, however, have shown that hemoglobinuria is a characteristic clinical symptom, especially in severe cases, terminating fatally.—Translator's Note.

(2.5 to 4 μ long and 1.5 to 2 μ broad); amœboid, and in the fully developed condition pyroform in shape.*

Demonstration of Parasites.—In the circulating blood these structures are found usually in only one or two, or, at most, 10 per cent. of the red blood corpuscles. The capillary blood of dead animals is more extensively infected, the blood of the renal capillaries being most infected, in which location as many as 80 per

FIG. 181



Texas fever. Boophilus bovis. *a*, recently hatched young tick. × 40 diameters; *b*, sexually mature male. × 10 diameters; *c*, sexually mature female. × 10 diameters. (After Smith.)

cent. of the erythrocytes contain the parasitic organism. For demonstrating Texas fever parasites, air-dried cover-glass preparations are kept in a hot-air incubator for from one to one and one-half hours at a temperature of 110° to 120° C., then stained for one-half to two minutes with alkaline-methylene blue, washed with water, dipped momentarily into 1 per cent. acetic acid, and again washed with water. In doubtful cases, the staining method of Romanowsky gives good satisfaction (with polychromic methylene-

* Wandolek changed the name of the organism of Texas fever to *Apiosoma bigeminum*, since Pyrosoma is preempted for a genus of Tunicates. As noted by Stiles, however, even the name chosen by Wandolek is not free. It is suggested, therefore, that the name proposed by Patton, *Piroplasma bigeminum*, is the proper species name for the parasitic organism of Texas fever.

blue, to which eosine is added until precipitation begins to take place, and differentiation with water slightly acidified with acetic acid). The Texas fever parasites then appear blue and the red blood corpuscles red.

Method of Infection.—The disease is transmissible by inoculating the blood of infected cattle into other cattle. Inoculation with the blood of apparently healthy cattle from the infected region also produces the disease, for these animals regularly contain intraglobular parasites in small numbers. Rabbits, guinea pigs, pigeons and sheep are immune. Under natural conditions, the infection is produced by means of ticks (*Ixodes bovis*, Riley; *s. Boophilus bovis*, Curtice). The eggs of these ticks are laid in pastures. The young ticks hatch in from two to six weeks, attach themselves to cattle, attain sexual maturity, and, after about 23 days, fall off for the purpose of depositing their eggs. The period of incubation, therefore, includes the time necessary for the development of young ticks out of females which have dropped (about 30 days), and the true incubation period of the disease (10 to 15 days).

Judgment.—Thus far, nothing is known concerning any disease in man due to eating the meat of cattle affected with Texas fever. Nevertheless, the meat of such animals is to be withheld from the market and rendered innocuous, for the possibility is by no means excluded that Texas fever may be distributed by means of meat traffic. Texas fever, therefore, possesses chiefly a veterinary police interest. In cases of the introduction of American cattle, the officials of the veterinary police should give special attention to this disease, which in 1894 was introduced into Hamburg by means of a transport loaded with American beef cattle, and caused all the States of the European continent to prohibt the introduction of American cattle.

Recent Investigations Concerning the Nature and Occurrence of Texas Fever.

Weisser and Maassen confirmed the belief that Texas fever was introduced into Hamburg by the importation of American cattle. They demonstrated the parasites discovered by Smith in smear preparations from the kidneys, spleen, liver, lymphatic glands and heart, but found them in greatest numbers in the capillaries of the kidneys and myocardium. The spherical structures found in the majority of the red blood corpuscles sometimes

resemble large cocci or diplococci. As a rule, there was only one spherical parasite in each red blood corpuscle, but in many cases there were two, and then they possessed a somewhat elongated, occasionally pyriform, shape. The parasites stained fairly well with the ordinary basic anilin dyes. The elongated forms, however, take the stain actively only in the wider ends. Good results were obtained on sections by the use of hematoxylin, methylene-blue and gentian violet, the latter in dilute solutions for a period of 24 hours.

R. Koch demonstrated that Texas fever occurs also in coast regions of German East Africa and that in this country also it is transmitted by ticks as in America. Koch confirmed the essential statements of Smith and Kilborne, but found the pyroform phase of the parasite even in mild cases of the disease.

According to Smith, the epizootic hemoglobinuria of Roumanian cattle, investigated by Babès, and the red water which occurs in South Africa, are related or identical with Texas fever. According to Starcovici, the epizootic of sheep investigated by Babès and called "carceag," belongs to Texas fever. Bonome in Padua found an endoglobular "amœbosporidium" in a disease characterized by him as "parasitic ictero-hematuria of sheep." However, according to Babès, the disease investigated by Bonome is nothing more than carceag.

Furthermore, the same findings as in Texas fever have been made by Sanfelice and Loi in hematuria of Sardinian cattle; by Celli and Santori in bovine malaria of the Campagna of Rome; by Krogius, von Hellens and Kossel in an epizootic hemoglobinuria of Finnish cattle; and by Laveran and Nicolle in an epizootic of sheep which is prevalent in the vicinity of Constantinople. Texas fever is widely distributed also in Australia.

Finally, according to the investigation of Jackschath and von Ziemann, it must be assumed that the so-called bloody urine of cattle, which is enzootic in Germany, is a disease etiologically related to Texas fever.

Diseases Caused by Infusoria.

(*a*) Nagana and Surra Disease.—The nagana and surra disease has been known for a long time in South Africa and India and has recently been identified by R. Koch in German East Africa. The disease, as shown by Bruce, is caused by a parasite which lives in the blood of the affected animals and which is transmitted

from one animal to another by biting insects; in South Africa and in Togo, by the tsetse fly (tsetse disease). The parasite does not, like the parasite of Texas fever, belong to the sporozoa, but rather to the infusoria, particularly to the trypanosomata (flagellate infusoria). It is two to three times as long as the diameter of a red blood corpuscle, has a fish-like form, and progresses with active sinuous motions between the red blood cells (Fig. 182). It is colorless, but takes anilin stains. The incubation period is from nine to eleven days. The onset of the disease may be recognized by the increase of bodily temperature and the appearance of parasites in the blood. Other characteristic symptoms do not appear. The

FIG. 182.

Trypanosoma of surra between red blood corpuscles. (After R. Koch.)

animals either die quickly with great depression, anemia and emaciation, or they become affected with the chronic form and die after several months.

Surra has been observed in cattle, horses and also in camels and elephants.

Judgment.—According to R. Koch, restrictions on the traffic in the meat of animals affected with surra are not necessary. In German East Africa it frequently occurs that an animal affected with surra has been slaughtered and eaten without the slightest injurious effect.

(*b*) DOURINE.—Schneider and Buffard found the cause of dourine to be trypanosomata, which resemble the organisms of surra and

tsetse fly diseases. The trypanosomata are 20 to 30 μ long, 1.5 to 2 μ wide, and may be easily transmitted to horses, dogs, rabbits, rats, mice and asses by subcutaneous or subdural injection, through the conjunctival sac, or by copulation.

2.—So-Called Calcareous Concretions in the Musculature of the Hog.

Meaning of the Term.—The term "calcareous concretions" is not appropriate, since we do not have to deal with pure lime deposit or calcareous concretions, but with calcified (petrified) animal parasites. It would, therefore, be more appropriate to speak of "calcified parasites" instead of "calcareous concretions" in the musculature. However, the term has become established in meat inspection and may as well be retained.

General Remarks on the Size, Occurrence and Principal Locations.—Calcareous concretions in the musculature of hogs may be of microscopic size, but as a rule they attain such size that they may be detected with the naked eye; their number varies exceedingly in individual cases. One observes all intermediate conditions between a few and innumerable calcifications. Hogs are sometimes observed in which the musculature appears to be literally sprinkled and permeated with white dots or tubercles. The chief location in cases where only a few calcifications are present varies, according to the nature of the parasites which furnish the basis of the calcification. In general, however, the abdominal muscles, muscular portion of the diaphragm, as well as the semi-membranosus (adductor magnus), which is exposed to view in the ordinary method of cutting up, are to be considered as the chief locations.

Etiology.—The following organisms lead to the formation of calcareous concretions: Miescher's sacs, trichinæ, cysticerci and echinococci.*

*The opinion of Duncker, that calcifications may occur also in hyaline muscle degeneration, which Duncker formerly considered as an actinomycotic disease, has not been confirmed. Among the large number of cases of calcareous concretions in hogs which I had occasion to inspect during a long period of years, no case was found which could have been attributed to the presence of degenerated muscle foci.

Differential Diagnosis.—The differentiation of calcareous concretions in the musculature of hogs is of great practical value, since the sanitary police judgment of it is not a simple matter. For example, calcified trichinæ are to be judged quite differently from calcified Miescher's sacs. The latter at most merely render of inferior quality the meat infested by them, while calcified trichinæ always make the meat dangerous. For it is an established fact that even apparently wholly calcified trichinæ may still be capable of producing an invasion (page 462). Trichinæ are not to be considered as disintegrated and dead until the whole worm body is affected with calcification and dissolves completely when treated with acetic acid. But, even in case of the presence of totally calcified trichinæ, it should be remembered that intact trichinæ may be present in one and the same animal with specimens which have disintegrated.

So long as the calcification of the structures in question is not complete, it is not ordinarily difficult to make a correct diagnosis from the organic remains which are preserved. Occasionally it is possible, even in cases of complete calcification, to restore the original conditions by treatment with weak acids (acetic acid or dilute hydrochloric acid), and thus to recognize with certainty the organic substratum of the calcification, as, for example, in normally calcified trichinæ. In other cases, such a possibility is excluded, since calcification may entirely destroy the structure of the organisms. In such cases, after treatment with weak or diluted strong acids, at most there remain mere fragments of tissue, which do not permit a definite conclusion as to the nature of the calcification.

For these doubtful cases the following characters may serve as criteria for recognizing calcareous deposits of different origins :

(a) Calcified Miescher's Sacs.

The varying size is the most conspicuous feature in calcified Miescher's sacs, which furnish the chief contingent of calcareous concretions in the musculature of hogs. In Miescher's sacs, calcification is by no means associated with a certain developmental stage, but may appear in sacs of small size. Calcification begins in Miescher's sacs in the form of an irregular granular deposit which appears at first centrally and thence spreads gradually toward the periphery. One also observes, however, S-shaped and spirally-coiled lime deposits in Miescher's sacs.

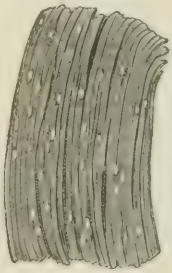
In cases of incomplete calcification of Miescher's sacs, one may still demonstrate the characteristic reniform and crescent-shaped corpuscles in the peripheral chambers (page 527). In cases of total calcification in Miescher's sacs, it is to be noted that they lie in the muscle fibers, possess an elongated form and are surrounded with a connective tissue membrane. This membrane, in contrast with the trichina capsule, dissolves upon the addition of potash lye (Duncker). Furthermore, the striation of the muscle fibers at the boundary of the sacs is unaffected, as contrasted with the condition in trichinæ (Fig. 175).

Calcified Miescher's sacs are, as a rule, visible to the naked eye, but some of them are demonstrable only by microscopic examination. They may occur in the heart as well as in the skeletal musculature.

Fig. 183.

Calcified Miescher's sacs from the musculature of a hog. The white points are the calcifications. Natural size.

Fig. 184.



Human muscle fibers with strongly calcified trichinæ. Natural size.

(b) Calcified Trichinæ.

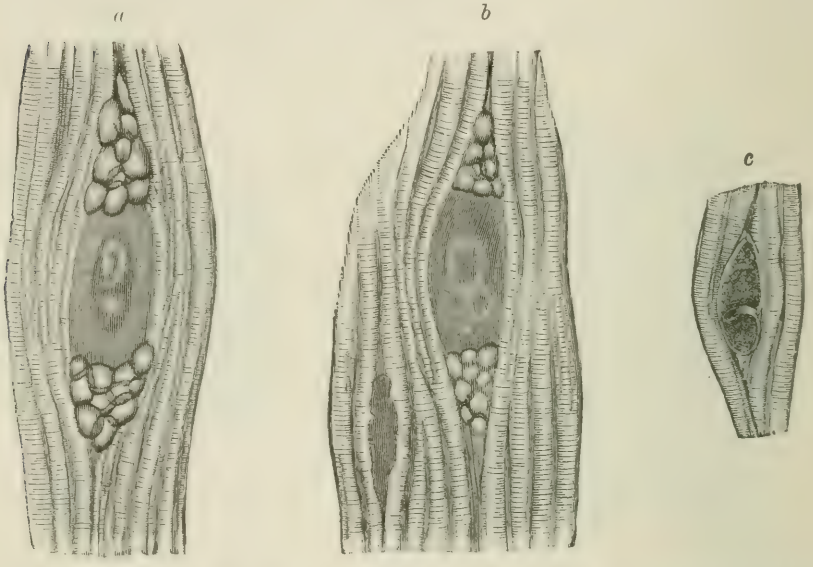
The intact trichina capsule possesses a length of 0.4 to .5 mm. As a rule, therefore, even when calcified, trichinæ are not readily visible to the naked eye, if calcification is restricted merely to the mass of the capsule. There are cases, however, in which calcification extends beyond the poles of the trichina capsule, so that the whole calcified structure attains a length of 1 mm. and becomes visible to the naked eye. These cases, however, are extremely rare in hogs, as contrasted with man, in whom muscle trichinæ frequently become macroscopically visible as a result of calcification (Fig. 184).

The rare occurrence of extensive calcification of the muscle trichinæ of hogs is readily understood if we consider that the deposition of lime in the capsule of muscle trichinæ usually does not begin until several months after the invasion. Most hogs, however, are slaughtered at from seven to ten months of age.

The calcification of muscle trichinæ in hogs may, as shown on pages 461 to 465, proceed in a normal and pathological manner.

In normal calcification, the glandular cloudiness extends from the poles of the trichina capsule over the whole capsule, in such a manner that the coiled worm finally becomes invisible. The latter,

FIG. 185.



Totally calcified trichinæ from one and the same hog. Neither the capsules nor the parasites could be made visible by the use of acetic acid. But at *a* the capsule is differentiated in spite of calcification and the outlines of the trichina can be seen. At *b* also the trichina can be seen. Fat tissue has developed at the poles of the calcifications. The calcareous concretion *c* is smaller than *a* and *b* although from the same hog, and shows no differentiation or fat tissue. It broke under pressure of the cover glass. Calcification probably began before development was complete.

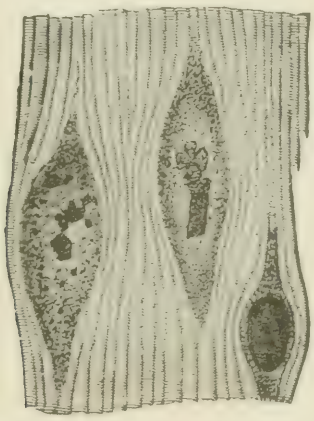
however, may still be completely intact and viable. In such cases the trichina capsule, as well as the parasite, may be rendered visible by the addition of acetic or weak hydrochloric acid. On th other hand, the capsule and the worm inclosed in it may finally become totally calcified, so that no positive finding can be made after treatment with acids (Fig. 185).

In cases of pathological calcification, no characteristic capsule

is formed on account of the extensive connective tissue proliferation in the region in the invading parasites. There is at most merely a hint at a capsule, and the trichinæ die prematurely. In these cases, calcification begins with the parasites and is usually so complete that there is nothing left by which to recognize them after the addition of acids (Fig. 186).

In both cases of total calcification of trichinæ, in which after treatment with lime-dissolving acids the presence of trichinæ can not be demonstrated, sufficient criteria for recognition are found in the elongated spindle-form (Figs. 185, 186), in the size, which does not exceed ½ to 1 mm., in the seat of lime deposits in muscle

Fig. 186.



Encapsuled calcareous concretions from dead trichinæ. Pathological calcification of trichinæ. (Leuckart.)

fibers, and in the alteration of the latter (disappearance of the contractile substance and the development of fat tissue at the poles of the lime deposits).

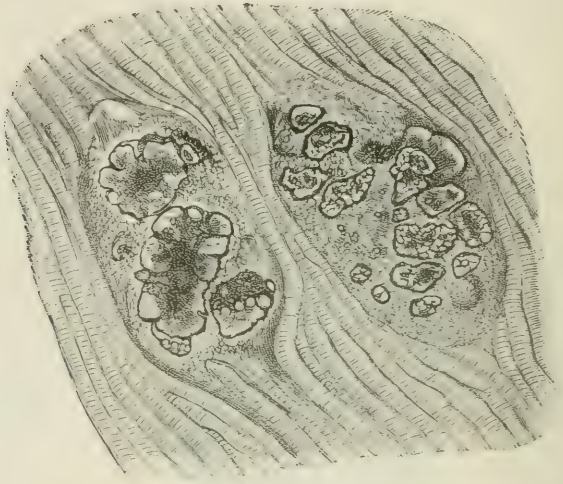
Calcified trichinæ are found in the skeletal musculature and not in the heart.

(c) Calcified Cysticerci.

The cysticerci which occur in the musculature of the hog may die in any developmental stage and may calcify after undergoing caseation. The size of calcified cysticerci varies, according to the stage of development in which the parasites die, between that of a millet seed and that of an oat kernel. The smallest calcified cysti-

cerci, however, are larger than the previously-described structures. Moreover, calcified cysticerci do not lie in the muscle fibers, but between them, and are characterized by a macroscopically-visible connective tissue membrane (Fig. 187). Moreover, the calcified content is usually separable from the membrane. Furthermore, in the calcified cysticerci of larger size, the characteristic hooks may be demonstrated under certain conditions and more frequently the calcareous corpuscles of the cysticercal neck are to be seen

Fig. 187.



Cysticerci calcified while young, with strongly developed connective tissue capsules. × 35 diameters.

(Fig. 125). Calcified cysticerci are found not only in the skeletal musculature, but also in the heart, since this forms a favorite location for cysticerci.

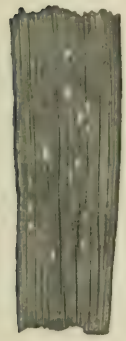
(d) Calcified Echinococci.

Calcified echinococci, as well as echinococci in general, are rarely found in the voluntary musculature. As a rule, they are observed in the musculature only in case of very extensive invasion in which the viscera are sprinkled with the parasites. This fact points the way to the recognition of calcified echinococci in the skeletal musculature. With regard, however, to the objective characters of calcified echinococci, it may be stated that the latter, like the cysticerci, lie between the muscle fibers and are likewise

always larger than calcified trichinæ. Moreover, in older calcified echinococci, remains of the characteristically-lamellated echinococcal cuticula, calcareous corpuscles and hooks are present (Fig. 163).

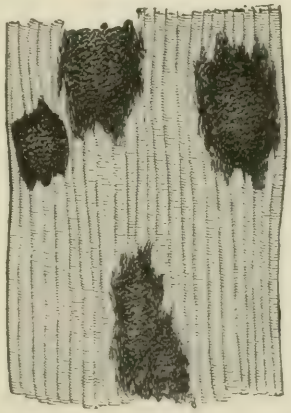
Tyrosin Deposits in Smoked Pork.—In smoked pork, most frequently in Westphalian hams, white spots occur, which, macroscopically, may be confused with calcified trichinæ, but which under the microscope are easily recognized as granular deposits. In these deposits, the occurrence of which was first made known by Virchow, we have a case of artificial product, due to the method of preservation. They are found in the form of irregular heaps

Fig. 188.



Tyrosin deposits from a Westphalian ham. Natural size.

Fig. 189.



Masses of tyrosin crystals in smoked pork, enlarged. (Leuckart.)

of crystals, varying in size from one to several millimeters, which exceed the breadth of several muscle fibers, and are surrounded by a capsule (Fig. 189). According to Voit, these deposits consist of tyrosin. Aside from their irregular form and their location, they are further distinguished from the parasitic calcification by the fact that they may be dissolved not only by means of acids, but also by potash lye. The process of dissolution in hydrochloric acid takes place without the development of carbon dioxide and in sulphuric acid without the formation of crystals of gypsum. If nitric acid is added to tyrosin deposits, a yellow solution is obtained, which, by the addition of potash lye, together with the application of heat, becomes red.

(According to Kitt, one may artificially produce the excretion of tyrosin crystals by laying meat in old alcohol which has already been used for preserving purposes).

Triple Phosphate Crystals in Decomposing Meat.—In decomposing meat, triple phosphate crystals are observed, which, as is well known, are distinguished by their coffin-lid form. These facts serve as sufficient criteria and aids in differentiating crystalline deposits which are formed post-mortem in the musculature from calcifications which arise during life on the basis of pathological processes.

XII.

PLANT PARASITES (INFECTIOUS DISEASES).

General Account.—In recent times, no field of pathology has experienced such scientific advancement as that of infectious diseases. If, according to Brieger's plan, all known diseases are divided into four groups, (1) diseases of traumatic origin, (2) infectious diseases, (3) metabolic diseases, and (4) neuroses, we have first to emphasize the unexpected development which infectious diseases have made at the expense of the other groups. It is only necessary to mention the discovery of the vegetable parasitic nature of certain infectious diseases of wounds, especially tetanus, which was previously considered as a neurosis, the etiological investigations of certain diseases of the intestines, inflammations of the lungs, etc., diseases the origin of which was formerly not explainable, or was merely attributed to a "cold." In addition to the extension of this field, attention should be called to the fact that the whole doctrine of infectious diseases was without a scientific basis until our time. Compare, for example, treatises on the infectious diseases of earlier times, say from the 60's of the preceding century, with those which we have to-day on the same subject. We may thus realize properly the great progress which the most recent of medical sciences, bacteriology, has shown in the field of infectious diseases.

It is frequently asserted that bacteriology has never fulfilled the expectations which have been entertained regarding its development, from the standpoint of practical medicine. As far as curative medicine is concerned, this must be granted. In prophylactic medicine, however, bacteriology, during the short period of time since its origin, has made the greatest progress, or has entered upon lines of progress. The doctrine of infectious diseases first became a well grounded science in consequence of the development of bacteriology under the school of Robert Koch. In this science the earlier problems and philosophical speculations have been replaced by positive didactic principles.

No less fruitful has been the effect of the progress of bacteriology upon meat inspection. The greatest number and at the same time the most important diseases of food animals belong to the infectious diseases. So far as these diseases are concerned, however, meat inspection is nothing more or less than applied bacteriology. The field of contagious diseases was formerly the weakest point in meat inspection. Gross empiricism and arbitrary doctrinarianism prevailed to a great extent in this field. At any rate it was the recognition of this fact which led Haubner to express the opinion that "the whole science of meat inspection can never be based and regulated on scientific principles." It may be asserted without fear of contradiction that the respect which the science of meat inspection has earned in recent times is attributable in no small degree to the fact that with regard to infectious diseases it operates upon more scientific principles than formerly. We have made great advances in the accurate determination of infectious diseases and in the sanitary police procedure with the meat of animals affected with such diseases.

In an address on "Antisepsis in Surgery," Johne once remarked that whoever had not learned to feel and think antiseptically would never become a master in surgery. The same may be said for meat inspection. Whoever is unable to think bacteriologically and to operate according to the requirements of bacteriology, grossly violates the elementary principles of hygiene, daily. To cite but one of the many examples: Persons who are unschooled in bacteriology neglect the disinfection of knives with which they have examined infectious alterations, tubercles, abscesses, etc. Other sound organs are incised with the same knives and are in this manner artificially infected.

It requires no detailed argument to show that the mere wiping of knives, which is, perhaps, never neglected, is not sufficient to remove infectious material.*

For the purpose of general orientation and in order to avoid repetitions in the discussion of the different infectious diseases, the following general remarks concerning infectious diseases and patho-

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*In order to prevent the bad results of this reprehensible and dangerous practice, it is desirable that every inspector carry with him in the abattoirs two knives, one for ordinary use and the other for use in examining diseased organs. If a knife becomes contaminated with virulent material, disinfection may be easily accomplished by passing it through a flame after a previous cleaning. This procedure offers the least difficulty, since flames are accessible in every room of an abattoir.

genic bacteria may be made in this connection. In a special study of bacteriology, however, one should not fail to consult Baumgarten, "Pathologische Mykologie"; for bacteriological technique, Kitt, "Bakterienkunde und Pathologische Mikroscopie"; and for animal diseases, Friedberger and Fröhner, "Pathologie und Therapie," Vol. II. Many statements in the following chapters are taken from these works.

Nature and Etiology of Infectious Diseases. — Infectious diseases are characterized by the fact that they are either transmitted by natural means from animal to animal and occasionally acquire an extensive distribution (plagues), or are artificially transmissible from one animal to another (infectious diseases of wounds), for the organisms of these diseases are living structures, capable of multiplication.

Pathogenic organisms are small plants (micro-organisms) which were formerly included among schizomycetes. The schizomycetes, together with the schizophytous algæ, constitute the large group of schizophytes. They are distinguished from related plants by the absence of chlorophyl, on account of which, like other fungi and animals, they must obtain their nutriment from organic materials which they metabolize in a peculiar manner (Zopf). Since, however, it has been shown that some chlorophyl-bearing organisms are found among the micro-organisms in question, the name schizomycetes has been replaced by the term bacteria. The organisms of infection are called pathogenic bacteria in contrast with the immense number of saprophytic bacteria which can not thrive in living tissue. Saprophytic bacteria, to which the large group of putrefactive organisms belongs, find suitable conditions of growth only when a portion of the body dies, or is not in contact with other living tissue; as, for example, when the blood supply in the part in question is cut off. As compared with the pathogenic bacteria, the pathogenic molds play only a subordinate rôle (see page 325).

Morphology of Pathogenic Bacteria.—The bacteria which are pathogenic for domesticated animals are either cocci (spherical bacteria) or bacilli (rods). Furthermore, distinction is made according to form between Leptothrices (thread bacteria), Streptothrices (branched bacteria) and Spirilla (spiral bacteria).

The cocci are further classified into diplococci, tetrads, sarcinæ, streptococci and staphylococci.

Diagnosis of Bacteria.—The morphological differences between bacteria constitute an important means of recognition. As a rule, however, the form alone is not enough for the identification of the species of bacteria; it is necessary to consider their characters: motility, behavior toward stains, growth on artificial nutrient media, appearance of pure cultures, production of certain chemical substances, and the effect of an artificial inoculation of experimental animals.

Biological Characters of Pathogenic Bacteria.—In the artificial cultivation of bacteria, it has been found that they have the power of growth and multiplication only under definite external conditions.

All bacteria require for their development protein in an easily assimilable form, salts, moisture and a certain temperature. The optimum temperature for pathogenic bacteria is that of the blood. The most of these bacteria, moreover, grow only in material of an alkaline or neutral reaction.

A certain proportion of pathogenic bacteria thrive only in the presence of oxygen; for example, anthrax bacilli. These bacteria are called aërobic in contrast with anaërobic species which multiply only when oxygen is completely excluded; as, for example, the tetanus bacillus. This difference is of great importance for meat inspection, for anaërobic bacteria are limited to local development in the animal body. They die in the circulating blood for the reason that it carries oxygen. Aërobic bacteria, on the other hand, can not form spores in the meat of food animals, since they do not find oxygen in this material (see "Anthrax").

In the experimental inoculation of bacteria into animals of different species, it appears that their infective power is by no means the same for all animals. Only a small proportion of bacteria are pathogenic for all domesticated animals and man—considering only these species for the present—(for example, the pyogenic bacteria, bacilli of anthrax, tetanus and tuberculosis). The majority of pathogenic bacteria, on the other hand, possess a power of infection merely toward a certain species of animal. This elective behavior of bacteria is of great significance in rendering judgment on the meat of animals suffering from infectious diseases.

It is one of the most remarkable facts of pathology that the most serious diseases of animals are not communicable to man. Rinderpest, contagious pleuro-pneumonia, blackleg and swine erysipelas can not be transmitted to man in any form. The human

organism appears to be absolutely immune or refractory to these plagues.

We seek in vain for a satisfactory explanation of this highly remarkable behavior of man toward the majority of the infectious diseases of domesticated animals. The investigator stands here before a complete mystery of nature, for the solution of which our wisdom is unavailing. We must content ourselves with a demonstration of the fact that the human organism treats the majority of bacteria which are highly pathogenic for animals absolutely, or at any rate when taken by way of the mouth, as saprophytes—that is, as harmless plants or bacteria.

In a number of other extremely devastating diseases of domesticated animals there is, to be sure, no absolute immunity, but a more or less complete insusceptibility to infection from eating the meat of animals which are affected with those diseases. This fact indicates that we have to distinguish between bacteria which are transmissible to man only by inoculation into the skin or subcutaneous tissue, and those which are at the same time transmissible by means of the alimentary tract (compare "Anthrax").

Chemism of Bacteria.—In spite of their microscopic size, bacteria develop vigorous chemical activity. They produce simple chemical bodies; for example, carbonic acid, ammonia, hydrogen sulphid, or peculiar organic substances the chemical composition of which is less understood than their action. We are under obligations to Brieger for calling attention to the chemism of bacteria and for having indicated the methods by which it is possible to isolate the poisons (toxins) produced by bacteria. The isolation of bacterial poisons is secured most easily by the filtration of living pure cultures or by the extraction of dead cultures. In this manner the best success has been had in obtaining the poisonous metabolic products of bacteria, and much better success has been achieved than by means of complicated methods of obtaining them in a pure state, since by the latter methods these bodies are partly destroyed.

The chemism of bacteria is very important for meat inspection, since it makes us acquainted with the fact that bacteria, although of themselves unable to produce an infection in man, are, however, capable of becoming injurious to man through the toxins produced by them (see "Sausage Poisoning").

Resistance of Bacteria and Other Toxins to Higher Degrees of Temperature.—Most pathogenic bacteria and a small

percentage of the toxins formed by them are destroyed by a high degree of heat. The knowledge of this fact possessed for a long time merely a scientific value. For the poor conductive property of meat offered considerable difficulties in the way of any thorough heating of the meat to a high temperature. These difficulties are now to be considered as obviated, since Hertwig has shown that by means of a steam cooking apparatus even the larger pieces of meat may readily be heated to the temperature of 100° C. This discovery constitutes one of the greatest steps in advance in the long and warmly disputed question concerning the utilization of the meat of animals affected with contagious diseases.

It is only by means of an accurate knowledge of the facts briefly indicated above, and which we owe to bacteriology, that we acquire a proper understanding of the nature and sanitary police judgment of infectious diseases. These facts also furnish us important criteria for dealing with the meat of animals affected with contagious diseases.

1.—Putrid Intoxication and Traumatic Infectious Diseases.

(a) Putrid Intoxication (Sapremia).

Nature and Origin.—In bacteriology distinction is made, as already indicated, between saprophytic and pathogenic bacteria. The former, in contrast with the pathogenic organisms, thrive only on dead bodies or, in living organisms, only on such parts as have lost organic connection with the vital operations (masses of blood, secretions, excretions, necrotic masses). The typical saprophytic bacteria, or those which are "strictly obligate saprophytes," are the bacteria of putrefaction. These bacteria are found only on dead parts which are in connection with the outside world, and not in the blood. They may, however, produce acute symptoms of poisoning since they possess the power of producing poisonous substances which may pass from the putrefactive foci, by resorption, into the blood. This sort of poisoning is characterized as putrid intoxication or sapremia.

A possibility of the development of sapremia is presented in cases of complicated bone fracture, pulmonary gangrene, perforative peritonitis and traumatic pericarditis, as well as in cases of placental retention.

A clinically-pure type of sapremia is perhaps seldom observed in practice. As a rule, sapremia is associated with previously-

existing diseases (inflammations of the lungs, stomach and intestines, pericardium and peritoneum), or, secondarily, local and general phenomena of an infectious nature become associated with the sapremic processes, as in cases of *retentio secundinarum*. This fact should be borne in mind in rendering judgment on the meat of sapremic animals.

Through the experimental investigations of Panum, Bergmann, Schmiedeberg, Selmi, Nencki, and especially of Brieger, with experimental animals, we have been made acquainted with the symptoms which appear after artificial inoculation with the soluble products of putrefactive bacteria. The result is an acute intoxication, ushered in with symptoms of paralysis and spasms. The intoxication may rapidly prove fatal with symptoms of respiratory paralysis, and is distinguished from infection by the fact that it possesses no period of incubation and also by the fact that it occurs the more quickly and violently the larger the quantity of inoculated material, and, finally, by the fact that the disease can not be transmitted further by inoculation with parts of the bodies of animals which have died in consequence of the intoxication.

With regard to the essential nature of the poisonous metabolic products of putrefactive bacteria, the prevailing view until recent years was that they were crystalline bodies. Brieger's clever and indefatigable work made it possible for him to isolate, according to his own method, a large number of well marked crystalline putrefactive products, which, in accord with Selmi, he characterized as ptomains. To this group belong muscarin, cholin, cadavarin, putrescin, neurin, neuridin, saprin, etc. Some of the ptomains discovered by Brieger are poisonous; others, on the other hand, are non-poisonous. At present the doctrine of ptomains is declared to be "an interesting error." Brieger and his assistant, Bocklisch, had already called attention to the fact that in the process of obtaining crystalline bodies from decomposing substances, the toxicity of the crystalline substance thus obtained was considerably less than that of the original extract, and in the report of his experiments in preparing ptomains from decomposing fish, Bocklisch states "the most poisonous properties are possessed by the extraction fluid freshly obtained from putrefactive broth. During the process of obtaining the bases, the toxicity of the extract is more and more diminished until it sometimes disappears entirely." It is now considered as demonstrated that not only with putrefactive organisms, but also with pathogenic bacteria, it is not so much the crystalline as the amorphous metabolic products which represent

the active poisonous bodies. According to Brieger, the poisonous metabolic products of bacteria, in contrast with the ptomains, are characterized as toxins.

Findings in slaughtered animals affected with sapremia: the presence of a decomposing area, which may be detected by its bad odor; other alterations, particularly of the parenchyma, may be entirely absent.

JUDGMENT.—No investigations have been made concerning the poisonous or non-poisonous character of the meat of sapremic animals. However, from the investigations of Panum, Bergmann, *et al.*, we know that fatal intoxication may be produced in experimental animals by subcutaneous, intraperitoneal, or intravenous inoculation of the soluble metabolic products of putrefactive bacteria. Furthermore, we know from the history of cases of sausage poisoning that decomposing substances may also be highly poisonous when taken per os. It should also be noted, as already demonstrated by Panum, and as is frequently shown anew by spontaneous poisoning from decomposing substances, that the poisonous bodies are not destroyed by boiling. Decomposing materials must, therefore, be characterized as injurious to health.

This, however, is not necessarily true of the meat of animals which are affected with putrid intoxication; for the living cell has the power of destroying the substances which accumulate in decomposing dead meat. We may best study this point in cattle, in the frequent cases of sapremia without fever as a consequence of *retentio secundinarum*. Animals which are seriously affected recover rapidly if the decomposing material is removed from the uterus by repeated irrigation with water. Such a matter could not be thought of in cases of infectious metritis or localization of pathogenic organisms in the uterine tissues. In sapremia, on the other hand, we may explain this result without reserve, according to analogous processes, especially the behavior of the organism in poisoning by alkaloids (see Chapter X), by the fact that the toxins circulating in the blood are broken up by the vital power of the living cell into harmless bodies, so that the organism may recover, while further resorption of these substances is prevented.

Brieger calls attention to the fact that in the normal body the larger portion of the alimentary canal is a focus of putrefaction in which the poisonous products of bacterial life are formed. A portion of these products (indol, phenol, cresol, scatol, derivatives of the aromatic series) unite to form harmless double associations by

combination with sulphuric acid, or, if this is not sufficient, with glycuronic acid (a derivative of sugar in the circulating blood).

The meat of animals which were affected merely with putrid intoxication and not at the same time with sapremia, according to this theoretical consideration, can not be considered injurious to health, as is the case with meat which undergoes decomposition post mortem. This assumption receives substantial support from the experimentally demonstrated fact that the blood of animals dead of putrid intoxication does not show a toxic action in inoculation experiments, and also by the fact, well known to all practicing veterinarians, that, annually, large quantities of meat of animals which are affected with stinking processes are eaten without harm. Thus, the meat of nearly all cattle affected with traumatic pericarditis is eaten without a single case of disease having been observed as a result. Moreover, in the literature of meat poisoning, no case of pericarditis is mentioned as a cause of disease.

The same may be said of meat from the frequent cases of perforative peritonitis in cattle. The author has observed a large number of cases of traumatic peritonitis with a malodorous exudation, in which the meat was eaten without any ill consequences.

In the literature of the subject one case of meat poisoning is mentioned which was apparently due to perforative peritonitis. This is the case of meat poisoning in Garmisch (Bollinger). In Garmisch, however, it was merely the consumption of the diseased organs which caused the acute symptoms of intoxication, while the meat proper or musculature was only slightly or not at all poisonous.

Only inflammations of the uterus with stinking exudation must be considered as very dangerous with regard to the consumption of the meat (see "Septicemia").

In traumatic pericarditis of cattle, it is a striking fact that fever is almost uniformly absent during life and that after emergency slaughter the parenchyma of the liver, heart and kidneys, as well as the skeletal musculature, shows a perfectly normal structure, rather than cloudy swelling and fatty metamorphosis, as observed in septic diseases. In cases of traumatic pericarditis, the animals die, in the vast majority of cases, not with symptoms of intoxication, but from mechanical obstruction of the cardiac action by means of foreign bodies which have penetrated the heart, or by the exudate caused by these bodies.

Traumatic pericarditis, in so far as the judgment of the meat is concerned, must be assigned a special position among the inflam-

matory diseases which are ushered in with decomposition of the exudate. I take side with the long customary practice, from the standpoint of practical veterinarians, of assigning the meat of such animals to the freibank as an inferior food material. It may, however, occur that the edematous infiltration of the musculature, in consequence of the obstruction to the circulation, or ichorous infarcts in the lungs, spleen and kidneys, in consequence of the perforation of the muscle of the heart by foreign bodies, may make necessary the absolute exclusion of the meat from market.

In all other processes, however, in which there is not such a typical course of the disease or such an abundance of experimental material as in the case of traumatic pericarditis, the meat must be regarded as calculated to injure human health. This judgment is indicated especially in putrefactive processes in the uterus on account of its frequent complication with septic metritis. It should also be noted that persons who have eaten the meat of animals affected with perforative peritonitis or *retentio secundinarum* uniformly assert that the meat and meat broth possesses a pronounced odor of decomposition. For this reason alone the meat in the diseases in question (perforative peritonitis and *retentio secundinarum*) should be absolutely excluded from market as highly unfit for food.

(b) Pyemia (Generalization of Purulent Processes).

Nature.—This disease has been defined as a blood poisoning with the appearance of metastases. In order rightly to understand the nature of pyemia, it is necessary to consider briefly the conditions of local suppuration.

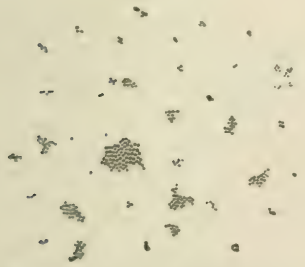
Suppurations belong to the more frequent pathological processes. They appear upon the mucous membranes as purulent catarrh; upon the serous membranes as purulent discharges; and in the tissues of various organs as purulent inflammations or abscesses. These processes may—and this is usually the case—run a local course, or, exceptionally, they may become general. In the latter case, we speak of pyemia.

Pyemia occurs in various forms. The essential point, however, is that purulent processes may be set up far from the orginal focus of suppuration, through the agency of the circulation, either in the form of metastatic abscesses or of an inflammation of the bone marrow, osteomyelitis. Abscesses which simply arise in the course

of the lymphatic vessels, as, for example, the formation of an abscess in the corresponding lymph gland in contagious coryza, do not fall under the head of pyemia.

Etiology.—Long before an accurate bacteriological investigation of suppurative processes had been made, Hüter stated the maxim, "no suppuration without living micro-organisms." While this, perhaps, can not be accepted without reserve, and while it must be admitted that there are pure chemical suppurations or those produced by chemical irritants, it is, nevertheless, certain that the great majority of suppurative processes, at least of those which possess interest for us on account of the possibility of their generalization, are of bacterial origin.

Fig. 190.



Staphylococcus pyogenes aureus from a pure culture on agar-agar. × 500 diameters.

Fig. 191.

Streptococcus pyogenes in microscopic pure culture in pus from a horse. × 500 diameters.

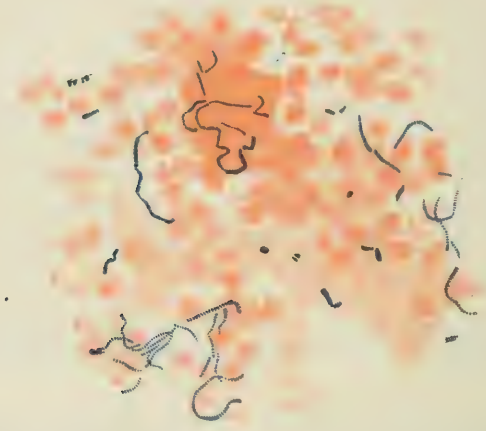
In the etiology of suppurations, two bacterial organisms are chiefly concerned, *Staphylococcus pyogenes aureus* and *Streptococcus pyogenes*. There are bacilli, however, which possess the power of producing suppuration.

Staphylococcus pyogenes aureus, first described and named by Ogston, possesses the power of transforming protein into peptones and thus of liquefying solid tissues. Furthermore, *S. pyogenes aureus*, like pathogenic staphylococci in general, forms two sorts of blood poisons which are to be considered as toxins in the narrower sense and, together with the poisons of the bodies of the cocci, exercises an influence upon the symptoms of staphylomycosis (Neisser and Wechsberg). According to investigations on man, *S. pyogenes aureus* is found chiefly in local suppurations, hot abscesses, phlegmons, suppurations of the lymphatic glands, traumatic suppuration of the articular and synovial membranes, suppuration of the parotid gland, idiopathic cerebrospinal meningitis

and other diseases. Moreover, it is usually demonstrable in acute osteomyelitis as well as in bacterial endocarditis of man. Finally, *S. pyogenes aureus* occurs in typical secondary metastatic abscesses. In pyemic metastases it is, according to Baumgarten, less frequent than *Streptococcus pyogenes*.

In the blood, *Staphylococcus pyogenes aureus* is found only exceptionally during traumatic fever and even then quite sparingly. An extensive multiplication of this organism within the circulating blood never occurs (Baumgarten). In the etiology of bacterial endocarditis, several conditions (pre-existing lesions of the introduction of staphylococcus in large masses of pus) appear to play

FIG. 192.



Streptococcus pyogenes in pus, stained by the Gram method.

an important part. Incidentally it may be mentioned that bacterial endocarditis, especially the ulcerating form, in consequence of the dissemination of infectious valvular deposits, may easily give rise to typical pyemia.

According to the investigations of Rosenbach and others, *Streptococcus pyogenes*, in contrast with *Staphylococcus pyogenes aureus*, is found in suppurations "which are distinguished by a tendency to superficial growth, and a slow, persistent, progressive and relatively slight tendency to the destruction of the affected tissue." This peculiarity is explained by the fact that *Streptococcus pyogenes* possesses a weaker peptonizing power than the staphylococcus. This fact explains, as Baumgarten states, the clinically highly important difference between the two species of

bacteria; viz., that suppurations caused by streptococcus lead to a general infection and to the formation of purulent metastases much more frequently than do the diseases caused by staphylococcus.

The demonstration of suppurative staphylococcus is simple. They may be beautifully demonstrated by the ordinary staining methods and by Gram's method (Fig. 192). Besides *Staphylococcus pyogenes aureus* and *Streptococcus pyogenes*, *Staphylococcus albus* and *S. citreus*, which, on account of their great similarity to *S. pyogenes aureus*, are characterized as varieties of the latter, are found in purulent foci. These two cocci are usually found associated with *S. pyogenes aureus*. They are, moreover, of rare occurrence and it is also doubtful whether they possess pyogenic properties.

The streptococcus of erysipelas (Fehleisen) is identical with *Streptococcus pyogenes*.

Bacillus pyogenes fœtidus, which has been isolated from abscesses with odoriferous contents, produces a stinking suppuration.

The above described micro-organisms are found most frequently in suppurative foci in man. In pus in domesticated animals, however, in a majority of cases, staphylococcus and streptococcus, as well as pyogenic bacilli, may be demonstrated. An accurate determination of the relative frequency of these bacterial organisms in the abscesses of domesticated animals would be a profitable field of simple bacteriological investigation. Lucet made a careful investigation of 52 cases in cattle, 32 of which were acute abscesses in different parts of the body, 9 cases of traumatic suppuration, 7 cases of puerperal pyemia and 4 other cases of pyemia. In these investigations Lucet found streptococci alone 9 times, staphylococcus alone twice, *Bacillus pyogenes bovis* alone 6 times, *B. liquefaciens pyogenes bovis* alone 4 times and *B. crassus pyogenes bovis* alone once.

In the other cases the different bacterial organisms were massed together or were associated with other bacteria. Lucet is of the opinion that the pyogenic cocci of cattle are different from those of man and are to be considered as distinct species (*Streptococcus* and *Staphylococcus pyogenes bovis*). Whether or not this assumption is well founded is still doubtful. *Bacillus pyogenes bovis* appears to be identical with *B. bovis renalis* (see page 307). *B. liquefaciens pyogenes bovis* is non-motile, liquefies gelatin, and intravenous inoculations of rabbits produce abscesses under the aponeuroses. *B. crassus bovis* is motile, grows readily, does not liquefy gelatin and forms drawn out threads in bouillon. It kills

guinea-pigs, when given in intraperitoneal injections, in from 36 to 48 hours.

De Jong isolated from metastatic abscesses in cattle a staphylococcus which resembled in many, but not all its properties, the *Staphylococcus bovis* of Lucet. The staphylococcus of De Jong does not liquefy gelatin and is thereby distinguished from *S. pyogenes aureus* and *albus*. On slant gelatin cultures, the staphylococcus forms either yellowish round colonies or a yellow surface growth which may occasionally assume a golden color. On agar and glycerin-agar growth is very luxuriant. It is possible to make the staphylococcus develop a white or yellowish color at will, according as the culture is kept at 37° C. or at the ordinary living temperature. The latter temperature produces a yellow color. The size varies between 0.6 and 1 μ. De Jong's staphylococcus proved to be non-pathogenic for dogs, rabbits and guinea-pigs in subcutaneous, intravenous and intraperitoneal injections. When injected into the anterior eye chamber of rabbits, however, it produces a purulent iritis, and, in dogs, when injected in the same manner, it produces ophthalmitis or purulent iritis and keratitis.

In infectious pleuro-peritonitis of hogs, which is ushered in with multiple abscess formation and adhesion of the parietal and visceral layers, Grips demonstrated extremely minute bacteria. In form, they possess a certain resemblance to the organisms of swine plague, but take the stain *in toto*. They liquefy blood serum and when injected into the body cavity of rabbits produce a purulent peritonitis.

Generalization of purulent processes by the formation of metastases is possible in two ways:

1. By dissemination of the pyogenic organisms through the lymphatic glands by means of the lymphatic vessels into the blood circulation.

2. By infectious emboli which become separated from the local thrombi in the region of the primary focus of suppuration.

Metastases appear first in the lungs (with the exception of pyemia in consequence of umbilical thrombo-phlebitis, see page 564). Individual bacterial organisms, however, or small emboli may pass through and beyond the lungs, since the pulmonary capillaries are large as compared with the capillaries of the systemic circulation. Moreover, the origin of extensive metastatic foci, in organs of the systemic blood circulatfon, is connected with the formation of infectious thrombi in the pulmonary venous system.

Slaughter Findings.—The anatomical characteristics of pyemia are, as already mentioned, of two kinds:

1. Local suppuration and the presence of osteomyelitis (chiefly pyemia due to staphylococci).

2. Local suppuration and the presence of multiple puriform and purulent foci in other organs (chiefly pyemia due to streptococci).

In food animals, the first form may occur after suppurations with obstructed discharge of pus (for example, in the horny part of the hoof and claws, joints, etc.). The second form appears most frequently in connection with suppurative processes in the umbilical vein (purulent umbilical thrombo-phlebitis), in the lungs, and after suppurative inflammations of the uterus. Furthermore, in cases of extensive phlegmonous processes, metastatic abscesses may be formed under the general integument and under the cutis of the hoof as well as in purulent inflammation of the joints and sheaths of the tendons.

Judgment of Pyemia from a Sanitary Police Standpoint.—While, according to the above discussion, locally restricted abscesses ushered in with granulations and opening to the outside world, as well as purulent catarrh of the mucous membranes, viz., fluor albus, must be considered as of no importance as far as the meat is concerned, and while, therefore, at most the meat may become a spoiled food material in consequence of emaciation due to suppuration, the conditions are quite otherwise in case of generalization of the process. The meat of pyemic animals must, as a rule, be considered as capable of injuring human health. As evidence of this, we have the experiments which were carried out by Karlinski and also cases of disease in man after eating the meat of pyemic animals, or the milk of cows which were suffering from streptococcal mastitis.

Karlinski fed milk which contained *Staphylococcus pyogenes aureus* to young pigs, rabbits and cats, and in forty-eight hours observed a general infection in six cases (staphylococci in the blood), purulent parotitis in five cases, acute intestinal catarrh with fatal results in seventeen cases, and general infection with the formation of miliary pus foci in the liver and kidneys in eight cases.

Holst observed four epidemics of moderate extent in man after drinking milk which came from cows affected with mastitis and which contained staphylococci which were not distinguishable from *S. pyogenes*. The persons in question were affected with an acute catarrh of the stomach and intestines and diarrhea.

In addition to the cases of meat poisoning in Röhrsdorf and Friedberg (q. v.), which were, perhaps, due to eating the meat of pyemic animals, we have another unexceptionable observation concerning the injuriousness of the meat from cases of pyemia. In Corres, near Maulbronn (Würtemburg), a large number of persons, according to Dambacher, became ill after eating the meat of a cow which was affected with osteomyelitis as a sequela of foot-and-mouth disease. All of the persons who bought the meat asserted that the marrow in the bones had become so purulent and fluid that it ran out of the bones upon cutting up the meat. The persons who ate the meat suffered from a general uncomfortable feeling, pains in the body and diarrhea, associated in one case with dizziness and faintness.

It should also be noted that *Staphylococcus pyogenes aureus*, despite the fact that it possesses no spores, is characterized by its great resisting powers. Thus, heating to a temperature of 99° C. does not kill it with certainty. At a temperature of 80° C. it is necessary that the heat be maintained for one hour in order to destroy the organism completely. Live steam, however, quickly renders the staphylococcus inactive.

Exceptions to the General Judgment Concerning Pyemia.—The meat of pyemic animals must, as a rule, be considered as injurious to health. There are, however, cases of pyemia which form an exception to this rule, namely, chronic metastatic abscess of the second form. The form of pyemia which is ushered in with the formation of metastases in the internal organs may heal. The pyemia of osteomyelitis, on the other hand, does not heal. This always causes death if the latter is not forestalled by emergency slaughter.

The healing of metastatic pus foci takes place in consequence of connective tissue encapsulation. The tense, anemic, cicatricial tissue which forms around the focus renders the latter perfectly harmless for the organism (elimination from the blood and lymphatic circulation), and the animal must be regarded as recovered when the primary focus has healed with or without artificial aid. Such cases of healed pyemia are not rare in food animals. Their differentiation from acute cases offers no difficulties.

With the presence of fresh infectious infarcts or puriform and purulent metastases are connected parenchymatous cloudiness of a mild form, splenic tumor and petechial spots in the kidneys similar to those in cases of osteomyelitis. If, on the other hand, the

purulent foci in the lungs, liver, spleen and other organs are encapsulated, the parenchymatous tissues appear to be absolutely unchanged. Moreover, the nutritive condition in cases where the metastatic foci are encapsulated is not in the least disturbed, while in acute pyemia it is always affected in a pronounced manner. It is not a rare occurrence that in well-fattened older calves, as well as in fat steers, the liver is permeated with numerous abscesses which owe their origin to a suppurative inflammation of the umbilical veins or to an old case of inflammation of the intestines.

In cases where the metastases of the second form of pyemia are healed, the meat is therefore to be considered as harmless in contrast with osteomyelitis, in which a similar process of healing is not observed.

Special Forms of Pyemia and Their Anatomical Characters.

1. *Bacterial endocarditis* appears either in the form of ulcers or granulations and tubercles on the valves. Only the first form possesses sanitary police significance, on account of the possibility of the formation of metastases. Bacterial endocarditis is regarded as an independent form of pyemia, for the reason that the point of entrance of the suppurative bacteria as a rule can not be demonstrated (cryptogenetic pyemia).

Ulcerous endocarditis with the formation of metastases is not very frequent in food animals. As an evidence of the existence of this disease, we have the presence in food animals of abscesses which occur most frequently in the lungs and spleen.

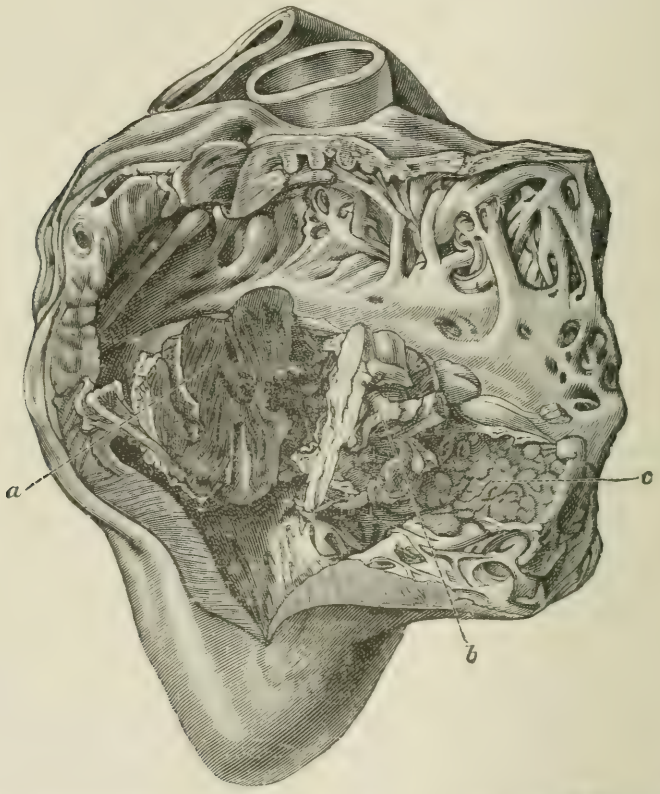
2. *Osteomyelitis* may also be cryptogenetic. As a rule, however, it is connected with easily-demonstrable suppurations in the hoof, claws, joints, etc., when, in consequence of obstruction to the escape of the pus, chronic abscesses are formed, or, when other favorable conditions are present, for the resorption of the suppurative bacteria.

Diagnosis.—The bone marrow is at first reddened and sometimes permeated with hemorrhages (hemorrhagic osteomyelitis). In cases of long standing, the reddened color, which in the acute stage may show through the thinner bones (as in the lower jaw), is diminished, while the marrow assumes a purulent fluid character, to such an extent that it flows out of the artificially opened marrow cavities. Furthermore, the periosteum, especially in the regions

of the articulations, and the articular surface in the capsules show ulcerative alterations.

3. *The Pyemic Form of So-called Lameness of New-born Animals.*—As a result of purulent infection of the umbilical vein, which is a frequent occurrence in calves, suppurative bacteria, or particles

FIG. 193.



Beef heart with valvular ulcerous endocarditis. *a*, cut surface of the thrombus on the ulcerous cardiac valve; *b*, base of the thrombus after artificial separation from the substratum; *c*, ulcerous part of the cardiac valve.

of abscess material, contaminated with the purulent bacteria, may be carried to the liver and, after passing through the capillary system of the liver, may reach the lungs and from this point may reach all other organs by means of the systemic circulation. Apparently the further development of the process depends upon whether the suppurative bacteria are isolated or obtain entrance

into the circulation in connection with particles of pus. Especially in general infections which occur immediately after birth and without macroscopically conspicuous alterations of the stump of the umbilical cord, one observes purulent processes in the joints and in the surrounding tissue (pyemic polyarthritis), with extension into the liver and lungs. The disease becomes noticeable by the appearance of fluctuating tumors on the joints. Most frequently the carpal and tarsal joint, less often the elbow and knee joints, and, finally, the hip joint, may become affected.

These are the usual clinical symptoms of so-called lameness of calves. In abattoirs, however, one frequently meets with other alterations which in their ensemble must be likewise characterized as a pyemic form of calf lameness. Reference is here had to single or numerous abscesses in the liver, occasionally also in the lungs, together with a primary purulent focus in the navel. These metastases, as already stated, usually do not become apparent clinically, but are quite unexpectedly found in well-nourished calves and older cattle after slaughter.

The last-named metastasis possesses a decided tendency to connective tissue encapsulation, while this process takes place less frequently and at a later stage in purulent processes in the joints and surrounding tissue. If the arthritic and periarthritic abscesses are actually isolated in the above-mentioned manner, we find at the same time that the intestines are perfectly intact (never cloudiness or petechiæ) and the nutritive condition good. In such cases it is sufficient to remove the diseased joints and surrounding tissue, in the same manner as in cases of encapsuled metastases in the liver and lungs. The removal of these organs suffices for the purpose of removing the harmful parts of the meat. If, in spite of the encapsulation, a disturbance of the nutritive condition exists, the meat is to be regarded as spoiled.

In acute, non-encapsuled abscesses, on the other hand, the meat is to be put in the same class with organs affected with purulent processes.

With regard to the etiology of lameness in new-born animals, Gmelin, in the case of an affected calf, found bacteria which, according to their morphological and biological characters, were to be classified with the group of hemorrhagic septicemia. The bacteria isolated by Gmelin had the power of producing symptoms of lameness in experimental calves. Zschokke, from the diseased joints of calves suffering with lameness, made cultures of *Bacterium coli*, which, after intravenous injection, produced a mild case

of polyarthritis in a calf. Casper and the author found pathogenic streptococci in colts, and Sohnle, pathogenic staphylococci as the cause of lameness.

4. *Pyemia After Swine Plague.*—In swine plague, it sometimes occurs that, in cases which do not run a fatal course, some or all of the diseased parts of the lungs, instead of healing, fuse together in consequence of the secondary localization of purulent bacteria. Pyemia may arise from these foci. If such is the case, one may observe abscesses in the liver, spleen, and, most numerously, in the skeletal musculature, which condition is rare in other forms of pyemia.

These pyemic hogs are, almost without exception, poorly nourished and, in part, exhibit the symptoms of hydremic cachexia. Since there can be no possibility of removing muscle abscesses, even in case of complete encapsulation, the meat of the animals in question must always be considered as injurious to health and unfit for food.

Cases of pyemia, as a result of swine plague, are not frequent. As a rule, the purulent lung areas are encapsuled in a sac-like form.

Similarly as in swine plague, pyemia may develop in infectious pneumonia of calves, sheep and goats.

In conclusion, it should be noted that in cattle a process of healing by multiple encapsulation occurs with comparative frequency, even in cases of extensive suppurations in the abdominal cavity. Thus, in cattle one frequently meets with hypophrenic abscesses which occupy a position between the diaphragm and the kidneys. In spite of their enormous volume these abscesses in the encapsulated condition do not badly affect the general health and nutritive condition of the animals. In removing these abscesses, the greatest precaution should be taken in order to prevent the pus from flowing over the meat in consequence of cutting the wall of the abscess. If such an accident happens, it is not sufficient that the meat be washed. The parts which are contaminated with pus must be carefully cut away with a knife and, in so far as the peritoneum and pleura are contaminated, these structures must be removed.

(c) Septicemia.

Nature.—Septicemia is defined as a malignant general disease usually associated with external lesions and without localization in

the internal organs. This definition agrees with the clinical and anatomical findings. More detailed etiological investigations, however, are required, especially in the domesticated animals, before we will know exactly what factors are of importance in the origin of septicemia.

Etiology.—It has been demonstrated empirically that after accidental wounds or operative interference on such parts of the body as offer especially favorable conditions for resorption (the large body cavities, joints, sheaths of the tendons) serious disturbances of the general condition may develop, often with a rapidly fatal attack. Under certain conditions, the dreaded symptoms appear after insignificant injuries of the skin or mucous membranes. The freshly-torn navel cord of new-born animals and the uterus post partum are predisposed in a high degree to the development of sepsis.

In ante-bacteriological times, it was considered sufficient to use the term "blood poisoning" as an explanation of the nature of sepsis. In fact, the rapid course and the pathologico-anatomical findings in septicemia present a striking similarity with simple intoxications, as, for example, with arsenic and phosphorous poisoning.

The first positive knowledge concerning septicemia, applicable, however, at first only to experimental animals, was obtained by means of the classical investigations of Robert Koch concerning the infectious diseases of wounds. In his experiments, Koch attacked the problem of the extent to which decomposition processes stand in relation to septicemia. He injected decomposing substances under the skin of experimental animals and thus determined that the latter are quickly killed by the use of large doses without the multiplication of bacteria in the blood or internal organs (sapremia), while when smaller doses were administered, typical bacterial diseases appeared (septicemia). The latter may be divided into two groups:

1. Diseases with a purely local multiplication of specific bacteria at the point of inoculation.

2. Diseases in which there is a simultaneous entrance of the bacteria into the blood circulation.

In the case of the first group, we may explain the origin of intoxication only by assuming the resorption of poisonous metabolic products of the locally-multiplying bacteria. In the second group, on the other hand, as stated by Baumgarten, we are compelled "to

postulate the coöperation of soluble toxic substances in producing the symptoms of disease." The enormous mass of micro-organisms multiplying in the blood is held to be sufficient to produce the symptoms of disease and death. Typical representatives of the second septicemia group are found in rabbit and mouse septicemia. Moreover, according to the similarity of the appearance of the pathogenic bacteria in the blood, anthrax, cattle plague, swine erysipelas and fowl cholera may be assigned to this group.

The latter forms of septicemia, however, have nothing in common with septic wound infection. From the standpoint of meat inspection, moreover, it is desirable to distinguish carefully between the above-named infectious diseases and wound septicemia. For, with the exception of anthrax, they represent for the most part diseases to which only one species of animal is susceptible. Furthermore, the narrow limits of the infective power of the organisms of septicemia, which were studied by Koch, are apparent from the fact that the organisms of the septicemia of house mice are perfectly harmless for field mice.

The investigations of the forms of septicemia of experimental animals can not, therefore, remove the uncertainty which exists concerning the origin of traumatic sepsis in man and domesticated animals. In the case of man it is assumed that in addition to pathogenic bacteria, the resorption of the toxic products of putrefactive bacteria which have become located upon the necrotic foci of the primary infection determine the clinical and anatomical symptoms of wound sepsis (Baumgarten). It has been demonstrated by numerous experiments on man and domesticated animals that pathogenic bacteria, especially the pyogenic streptococci, are present in septic wounds. The presence of these bacteria in the blood is also considered as demonstrated. They are found in the blood, however, always in small numbers.

Hauser describes a case of formal symbiosis between streptococci and the chief species of putrefactive bacteria, *Proteus vulgaris* in an ichorous abscess formation. It was believed that the process was to be explained by assuming that the streptococcus infection followed a necrosis of the tissue, which made it possible for *Proteus vulgaris* to multiply. In this connection, Hauser cites the well-known experiments of Monti, from which it is apparent that streptococci which have already lost their virulence toward normal animals may again attain it if the animals are inoculated at any point whatever with the metabolic products of cultures of proteus. If these observations may be generally applied, we would have to do

with a formal symbiosis between streptococci and proteus. "The streptococci multiply in the living tissue and make possible the vegetation of proteus by their necrosing action. Proteus, however, in consequence of the poison produced by it, weakens the resisting power of the tissue and thereby renders more easy the entrance of streptococci, which simultaneously undergo an intensification of their virulence."

It is doubtful whether the resorption of putrefactive toxins plays a uniform part in the origin of sepsis in domesticated animals. For, in the case of a very frequent wound sepsis, viz., the septic form of calf and colt lameness, stinking gangrene is not present, as a rule, at the point of entrance. This process may also be entirely absent in septic metritis of cows and in septic infection of the castration wounds in horses. I emphasize this for the reason that it would be a fatal error of the expert meat inspector to assume that sepsis was present only when necrosis and putrefaction of the necrotic parts in the primary focus were observed.

We do not yet know with certainty what bacteria may cause common wound sepsis in our food animals. From the similarity of the course of certain wound infections in domesticated animals and in man and from the results of bacteriological investigations on this subject, we may conclude that in the forms of septicemia in the domesticated animals, pyogenic streptococci play the most important part. Further investigations are required to determine in how far other specific organisms of traumatic septicemia occur in the different domesticated animals. By means of bacteriological investigations in connection with certain cases of meat poisoning, it has been determined that bacteria which belong to the coli group possess the power of producing septicemia in food animals (see under "Bacteriology of Meat Poisoning").

Diagnosis.—Until the mooted questions are finally settled, we are compelled to make the diagnosis of sepsis on the basis of the course of the disease and the pathologico-anatomical alterations. Under certain circumstances, it is very difficult to make a diagnosis. In general, however, the following phenomena should render diagnosis certain:

1. *Intra vitam:* High fever,* pronounced disturbance of the general condition, great weakness and depression.

* In cattle, in which septic diseases possess the greatest sanitary interest, high fever is observed only in typical infectious diseases and in diseases of a septic character.

2. *Post mortem:* No gross lesions of the internal organs; uniformly cloudy swelling of the liver, heart and kidneys; swelling of all the lymphatic glands, as well as petechiæ under the serous membranes, in the mucous membranes and in the lymphatic glands.

The absence of gross lesions in the internal organs, or the small amount of alterations, which apparently are out of proportion to the serious phenomena during life, must create a suspicion of sepsis in every case. For rendering the diagnosis certain in doubtful cases, Basenau has proposed a serviceable bacteriological method (see under "Meat Poisoning").

Judgment of Meat of Animals Affected with Sepsis.—No other disease possesses such importance for meat inspection as sepsis, tuberculosis of cattle not excepted. The latter is easily recognizable. The diagnosis of sepsis, on the other hand, requires extensive medical training. Furthermore, as regards the meat, septicemia is to be considered the most dangerous of all diseases of domesticated animals. For details on this subject, see the section on "Meat Poisoning." In this connection it may be simply noted that the meat of animals affected with sepsis is to be excluded from the market as dangerous material, unfit for food.

Special Forms of Septicemia in Food Animals.

1. *Septic Form of Calf Lameness* (*Polyarthritis septica*).—This disease appears even in the first days of life and is characterized by great weakness and depression as well as by the development of diffuse hot swellings around and in the joints (chiefly in the carpal and tarsal joints, also in the hip and knee joints). The navel is discolored and exhibits a flabby condition. A dirty, red secretion oozes out on pressure. There are no granulations. The parenchyma of the liver and kidneys as well as of the myocardium is colored grayish-red and of soft consistency. The tissue around the joints is affected with serous infiltration. The articular capsules are distended with a yellowish fluid in which a fibrinous coagulum is found.

Diagnosis.—While the septic diseases of all other food animals render emergency slaughter necessary outside of the abattoir, septic calf lameness may be observed in abattoirs, especially in regions in which the sale of so-called fasting calves (see page 238) is not prohibited. This is possible on account of the fact that most calves

are transported to abattoirs in wagons, and thus diseased animals may be introduced without attracting attention. In another place I have called attention to the fact that carpal and tarsal joints which are opened in the butcher's ordinary method of slaughtering should be carefully examined in each calf.

Judgment.—Among the diseases which have caused cases of meat poisoning, the so-called calf lameness plays an important part, and the usual form is septic polyarthritis. For, almost without exception, "yellow water in the joints" is reported as being found after slaughtering the calves in question. The meat of such animals must, therefore, be considered as, in a high degree, calculated to injure human health.

2. *Hemorrhagic Enteritis of Calves*, a septic disease of uncertain origin, which may rapidly run a fatal course. I had an opportunity to study the symptoms of the disease in calves which were used for obtaining lymph. The animals suddenly refuse their food, exhibit an elevation of body temperature up to 42° C., show depression and often die within 12 hours. Post mortem, a reddening of the whole small intestine is observed together with bloody-colored intestinal contents, considerable swelling and hemorrhages on the mucous membrane. As a rule, a cloudiness of the parenchyma is not observed in the peracute course of the disease. On the other hand, a hemorrhagic swelling of the mesenteric glands is usually absent, as well as petechiæ under the serous membranes. Frequently there is splenic tumor. It is highly probable that the disease of sucking calves, as described by Notz, which, on account of the associated splenic tumor, he was inclined to ascribe to the effect of blows from horns, is identical with this hemorrhagic enteritis.

Differential Diagnosis.—In a superficial examination the alterations in the intestine which occur in cases of ordinary diarrhea of calves may be confused with those of hemorrhagic enteritis. In the former, however, neither hemorrhages in the mucous membrane nor in the mesenteric glands and serous membranes are observed.

Judgment.—Injuries to human health from eating the meat of animals which are affected with hemorrhagic enteritis are unknown. Until positive proof of the harmlessness of the meat of such animals is afforded, we must suspect it, *in dubio*, as being injurious to health.

3. *Septic Metritis.*—Septic metritis of cows, together with so-called calf lameness, furnishes the chief contingent to those dis-

eases of domesticated animals in which the consumption of the meat may cause epidemics in man. Frequently, metritis develops in connection with the retention of the placenta. In other cases, on the contrary, we have to do simply with inflammatory processes following difficult parturition, during which injuries to the sexual passages have occurred. Such uterine injuries, according to all our information, furnish unusually favorable conditions for the localization of the bacteria of sepsis.

The clinical symptoms are those which are typical of sepsis. At the same time we observe more or less important local phenomena of an inflammatory nature in the sexual passages. After slaughtering animals seriously affected, the well-known alterations of the parenchyma are found. The mucous membrane of the uterus exhibits diphtheritic desquamations and ulcers; the iliac glands are much swollen. Moreover, symptoms of fibrinous or sero-fibrinous peritoneal inflammation may be present.*

4. *Septic Intestinal Diseases in Cattle.*—The history of cases of meat poisoning has acquainted us with intestinal diseases of cattle of an undoubted septic nature, the symptomatology of which, however, is still incompletely known. Five such cases of septic intestinal disease have acquired notoriety through the cases of meat poisoning at St. Georgen, Schönenberg, Lauterbach in Hessen, Frankenhausen, and through the extensive epidemic in Kalk (*q. v.*).

5. *Septic Mammary Diseases in Cows.*—The ordinary mammary inflammations, which are so frequently brought to the attention of the practical veterinarian, are of a quite harmless nature during the life of the animals and so far as the meat is concerned. As shown on page 314, this holds true for phlegmonous mastitis and for the typical parenchymatous inflammations of the udder, produced by the mastitis bacteria of Kitt. These inflammations, as such, never give occasion to emergency slaughter, since they disturb

* Albrecht in Munich, in connection with the report of two cases of poisoning after eating the meat of cows which were affected with septic metritis, observes that in timely slaughter and thorough bleeding, he has never observed injurious consequences from eating the meat of animals suffering with this disease. In such cases the gangrenous parts are removed and the rest of the meat is thereupon freely admitted to the market. Albrecht, however, recommends the greatest precaution in judging the meat of animals affected with septic metritis if they are not slaughtered until the agony of the disease has appeared, since the bleeding in such cases is imperfect and extensive gangrenous disturbances are present.

the general health of the animals only slightly. The conditions are quite different in the case of septic inflammation of the udder, the knowledge of which we owe to the history of cases of meat poisoning.

Diagnosis.—Septic mammary inflammations run a quite different course from that of ordinary inflammations of the udder. They are ushered in with such a serious general disturbance and with such a depression that the owners of the animals slaughter them in order to forestall natural death.

Nothing is known concerning the condition of the internal organs in the above-mentioned cases. A case of septic mastitis in cattle, which was observed by the author, showed, after emergency slaughter, all of the anatomical characters of sepsis—excessive cloudiness of the liver, which was yellow and soft, and of the heart and kidneys. Extremely numerous petechiæ were found under the serous coat of the intestine, under the pulmonary pleura, and under the epicardium. Before slaughter the following conditions were conspicuous in the affected udder: All four quarters were swollen to about three times their natural size and were firm and hot. No milk was evacuated from the teats, merely a small quantity of a watery secretion. The animal had not eaten for three days, but had exceedingly great thirst. The internal body temperature was 41.5 to 41.9° C. On the third day the vital powers became so reduced that a fatal issue was feared.

6. *Petechial Fever*, blood spot disease (morbus maculosus), is the name of a disease of horses, the etiology of which is unexplained. The name, blood spot disease, is given to this affection on account of its most conspicuous symptom, hemorrhages, which may appear in all the organs. These hemorrhages, in connection with the regular parenchymatous alterations, characterize blood spot disease as a pronounced septicemia. From an etiological standpoint, it is important to note that petechial fever is frequently associated with previous attacks of an infectious disease, especially contagious coryza and pneumonia.

Clinical Symptoms.—Petechiæ of the visible mucous membranes, swellings of the skin which may reach an acute stage and show a tendency to necrosis; internal body temperature 39.5 to 40° C.

Anatomical Findings.—Petechiæ in the skin and subcutis, as well as in all the mucous membranes, lungs, spleen, myocardium and voluntary musculature; also bloody, gelatinous discharges in

the subcutis under the mucous membrane and in the skeletal musculature. Pronounced cloudiness of the liver and kidneys, heart and skeletal musculature.

With regard to the sanitary judgment of petechial fever, attention should be called to the fact that in Zittau (see "Meat Poisoning"), a large number of families of workmen became sick after eating the meat of a horse, which, according to all appearances, had been affected with this disease.

According to the more recent observations, a "blood spot disease" appears to occur also in cattle. The relation between it and the petechial fever of horses is not plain from the published reports. According to the anatomical findings, however, we must classify the disease in cattle with septicemia.

The author has observed a number of cases in hogs which began with alterations similar to those which are observed in petechial fever of the horse.

In the blood spot disease of man (purpura hemorrhagica), the identity of which with the blood spot disease of horses is, however, not demonstrated, Kolb found non-motile plump bacilli, three to four hours after death. "Bacillus hemorrhagicus" of Kolb is pathogenic for dogs, rabbits and mice, but not for guinea pigs and pigeons.

(d) Malignant Edema.

Occurrence.—We owe the first information concerning malignant edema to the inoculation experiments of Robert Koch, with garden soil. The disease occurs after accidental injuries and in connection with operations on horses. Kitt has also shown that it may be transmitted artificially to horses, calves, sheep, goats, hogs and dogs, as well as to chickens and pigeons. According to Arloing and Chauveau, cattle are immune to malignant edema. According to Kitt, however, a bacillus of edema may cause extensive local swellings in cattle.

Clinical Symptoms.—Malignant edema is characterized by the appearance of rapidly extending crackling edemata in the subcutis, whereby the overlying parts of the skin show a tendency to gangrene.

Bacteriology.—This disease is caused by the edema bacillus. This organism is somewhat more slender than the anthrax bacillus,

possesses rounded ends and sometimes, but not always, exhibits motility. The bacilli are arranged in apparent threads. Spores are formed in the individual bacilli with a spindle-shaped or tadpole-shaped swelling of the latter. The edema bacilli are found as pronounced anaërobic organisms only locally in the edematous areas and not in the blood vessels. It is only in mice that the multiplication of the bacilli has been observed in the blood, and this for an unexplained reason. The edema bacilli form spores in carcasses, when they cool slowly or are artificially exposed to a high temperature.

It is worthy of note that the edema bacilli are regularly found in the humus layer of the soil. Furthermore, they are found in the alimentary tract of living animals. This is of value in making a differential diagnosis, for the bacilli, in carcasses of animals which have been left unopened from twelve to twenty-four hours, may wander into the neighboring organs, including the spleen. Gaffky has demonstrated this condition in guinea pigs which were violently strangled and kept in an incubator, and Lustig in horses which had died of colic.

FIG. 194.

Edema bacilli from the subcutis of a rabbit dead of malignant edema. Some rods are distended with spores. × 500 diameters.

For details on differential diagnosis, see under "Anthrax" and "Blackleg."

SLAUGHTER FINDINGS.—The abnormal anatomical finding is restricted for the most part to the edema of the subcutis. The internal organs are intact; splenic tumor is absent.

JUDGMENT.—Thus far nothing is known of any injury to human health from the consumption of the meat of animals which have been affected with malignant edema. We may, perhaps, in general, exclude the possibility of an injurious character of the meat when we consider that the bacilli of malignant edema are found in the intestinal contents of perfectly healthy animals as harmless saprophytes. However, the meat of animals subjected to emergency slaughter on account of malignant edema is to be treated as spoiled or highly unfit for food, according to the objective alterations.

(e) Tetanus.

The unmistakable clinical symptoms of tetanus obviates the necessity of a special description.

Bacteriology.—Tetanus is caused by the tetanus bacilli (Nicolaier-Rosenbach). They are delicate, slender rods, which, in a sporeless condition, possess a brush-like appearance, while in the spore-bearing form they have a pin shape. The tetanus bacilli are strictly anërobic, and thrive, therefore, only in the subcutaneous, submucous or in the deeper-lying tissues and do not pass into the blood. They produce toxines of an unusually violent action, the resorption of which causes the symptom-complex of tetanus.

Fig. 195.

Tetanus bacilli, partly spore bearing, from a pure culture. × 500 diam.

Tetanus bacilli, outside of the animal body, are widely distributed in the surface soil.

Occurrence. — This infectious disease is most frequent in horses after accidental or intentional injuries; also in goats after castration and in cows after the retention of the placenta. The occurrence of infection presupposes a lesion of the skin or mucous membrane, or at least a catarrh of the mucous membrane (Thalheim). In new-born lambs, tetanus is observed enzootically in consequence of the infection of the open navel wound.

Judgment.—Before it was demonstrated that tetanus is an infectious disease, it was considered as a simple affection of the nervous system, or a neurosis. Formerly, no hesitation was felt concerning the consumption of the meat of tetanized animals; no injuries to health have been observed in consequence of this. Furthermore, Gerlach states that he has fed the meat of tetanized horses in large quantities to hogs without causing any results in the experimental animals. With a knowledge of the true nature of the disease, we must, nevertheless, investigate the question whether from a scientific standpoint the meat can be considered as injurious

to health. According to the investigations of Sormani, this question is to be answered in the negative. Sormani demonstrated that animals could be fed for a long time with pure cultures of tetanus bacilli without injury to their health. The digestive tract endures a dose 10,000 times larger than the fatal dose in subcutaneous inoculation. Accordingly, Sormani considers the meat of tetanized animals as perfectly harmless. According to Fermi and Celli, the tetanus toxin is rendered inactive by the hydrochloric acid of the gastric juice.

It was *a priori* probable that tetanus bacilli were incapable of producing an infection from the alimentary tract, since otherwise tetanus must be one of the most frequent diseases of man and the domesticated animals, for the tetanus bacilli are frequently eaten along with various vegetable food materials.

While the meat of tetanized animals can not be considered as injurious to health, it nevertheless possesses the property of a spoiled or inferior food material; for we find, as a rule, in tetanized animals defective bleeding; parenchymatous degeneration, not only of the heart, but also of the skeletal musculature; an abnormal softness; and, occasionally, a peculiar, faintly-sweet odor.

Resistance of the Tetanus Toxin to High Temperatures.—Kitasato demonstrated that the toxic metabolic products of the tetanus bacilli are totally destroyed by a temperature of 65° C., or more, for a few minutes (five minutes or even less). By cooking the meat of tetanized animals, therefore, we may free it of all injurious properties, since meat contains only the toxic material and not the organisms of tetanus.

2.—Infectious Diseases Which May Occur in Man as Well as in Domesticated Animals.

(a) Anthrax.

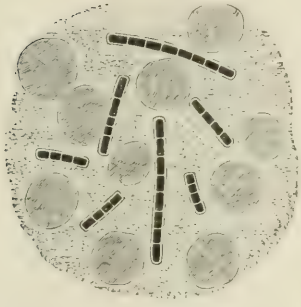
General.—Anthrax is the best understood and most thoroughly studied infectious disease. That the entrance of anthrax bacilli produces anthrax is a discovery which preceded all other bacterial investigations and occurred, as is well known, during the middle of the previous century.

Morphology and Biology of Anthrax Organisms.—Anthrax organisms are observed in a vegetative form (rods and threads) and

in the form of spores. Anthrax rods or bacilli, as was first shown by Lüpke, consist of cells from 1.5 to 2 μ long. In a slowly-developing case of anthrax the cells may reach a length of 3 μ (Johne). On artificial nutrient media, the rods develop into extremely long, straight or coiled threads in which spores are formed (Fig. 197). Spore formation occurs only in the presence of abundant oxygen under suitable conditions of temperature. The limits of temperature lie between 18° and 34° C., the optimum being 30° C. The spores are formed, however, neither in the living animal body nor in the intact animal carcass.

Furthermore, in the diagnosis of anthrax, it is important to remember that the rods are non-motile and are surrounded by a

Fig. 196.



Anthrax bacilli from spleen of an infected mouse, showing capsules and division walls between individual cells. Some of the longer cells are constricted in the middle. × 800 diameters.

Fig. 197.

Anthrax threads in process of sporulation, and free spores. × 2000 diameters.

characteristic capsule or gelatinous membane, by means of which the individual cells are held together.

The capsule or gelatinous membrane is of greater or less thickness and surrounds the individual anthrax cells on both sides and on the ends in a uniform layer. Such a conspicuous capsule is wanting in all bacteria which might give occasion to confusion with Bacillus anthracis, especially the so-called cadaver bacillus (Johne). The capsules of anthrax bacilli, according to Johne, may be demonstrated by the following process:

1. A *lege artis* cover glass preparation, air-dried, is grasped with the pincers in the ordinary manner and passed three times through the flame.

2. Then, in a horizontal position, the smeared side up, a 2 per cent. aqueous solution of an anilin stain (preferably gentian violet) is dropped on the preparation until its surface is completely covered; thereupon

3. While in the same position, the preparation is passed through the flame or held somewhat above it until a slight steam arises from the staining solution.

4. Wash with water; then 8 to 10 seconds in a 2 per cent. solution of acetic acid; then a second careful washing in water.

5. The cover glass is laid upon the slide, the water is removed from the upper side of the cover glass by means of filter paper, and the preparation is examined (directly in water) by a magnification of at least 400 diameters, or by oil immersion.

Klett recommends a subsequent warming of the stained preparation in order to demonstrate the capsules of the anthrax bacilli. Klett described his process as follows:

The cover glass preparation, well dried in the air, and, if possible, allowed to lie for a few hours, is passed three times through the flame, *lege artis*, then dipped in an aqueous rapid stain (violet or fuchsin) and washed. Finally, the wet cover glass is laid upon the slide and examined in the ordinary manner.

Lüpke, while approving Klett's method, recommended a still simpler procedure; viz., dropping a 2 per cent. solution of gentian violet on the preparation, then heating slightly and washing thoroughly with water. As the author has frequently convinced himself, this method really makes possible a very beautiful differentiation of the anthrax bacilli into capsules and individual cells.

A second method of staining capsules, which was proposed by Klett, renders possible a fine double stain characteristic of anthrax bacilli. A cover glass preparation, well dried in the air, and preferably left lying for a few hours, is to be made up properly in the ordinary manner. Then an alcoholic aqueous solution of methylene blue is dropped on the cover glass; afterward the preparation is warmed over a flame until it boils and is subsequently washed thoroughly with distilled water. It is then treated with an alcoholic aqueous solution of fuchsin for not more than five seconds and washed again. By this method of staining, the bacterial bodies appear dark-blue, the membranes a light rose-red and their contours dark-red (Fig. 1, lithographed plate).

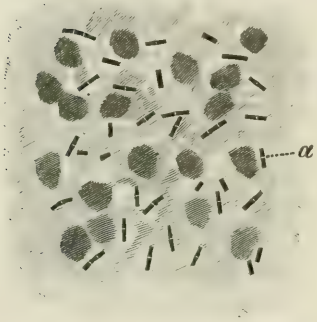
Finally, W. Raebiger has proposed a very similar process for demonstrating the capsules on anthrax bacilli. Raebiger dissolves

15 to 20 gm. of gentian violet in 100 to 150 gm. of formalin, allows the preparation to stand over night, and filters; the filtered preparation is dropped on the air-dried preparation without previous heating and, after 20 seconds, is washed off. Capsules are then demonstrated only on anthrax bacilli. Spurious capsules, as Raebiger asserts, never appear after this procedure.

Klett has called attention to the fact that the capsules are very weak when the preparations are taken from cadavers which have lain for a long time. According to his method, however, he was able to demonstrate capsules very plainly on anthrax bacilli four days post mortem. In anthrax in horses Schmidt was able to make the capsules appear only to a slight extent.

In the ordinary method of staining, in which the capsules are not differentiated, we may observe that the ends of the individual

Fig. 198.



Anthrax bacilli from the cardiac blood of a mouse, with "clavate polar swellings." × 500 diameters.

Fig. 199.

Cadaver bacilli (edema bacilli from the subcutis of an artificially infected rabbit). × 500 diameters.

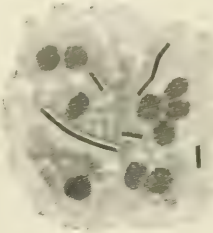
bacterial cells are broader than the remainder of the cell body (Fig. 198). This phenomenon, previously characterized as clavate end-swelling, arises in consequence of the contraction of the middle of the bacterial body before division (Johne).

Anthrax bacilli are found especially in the capillaries of the internal organs, particularly the spleen, intestines, mesenteries and lungs. On account of the retention of the anthrax bacilli in the capillaries, their demonstration in the large vascular trunks during life may be a difficult matter.

Differentiation of Anthrax Bacilli and So-called Cadaver Bacilli.—Attention has already been called (page 575) to the fact

that in the alimentary canal of living animals, edema bacilli are found and that these organisms penetrate from the intestines into the neighboring organs, especially into the spleen and liver, if the cadaver has lain unopened for from 12 to 24 hours. For this reason the edema bacilli which occur in cadavers, or, as they may be briefly termed, cadaver bacilli, are of great practical significance in the bacteriological diagnosis of anthrax. Cadaver bacilli also form spurious threads, like anthrax bacilli. The individual bacilli, however, are more slender and longer than the anthrax bacilli and are not squarely cut at the ends like the latter, but are rounded, or end obliquely. Furthermore, the cadaver bacilli form spores in the carcass (Fig. 199) and possess no capsule like anthrax bacilli. It sometimes occurs, to be sure, that a capsule-like, faint, lateral seam appears on the cadaver bacilli. This spurious capsule, however, is usually unilateral and without an external contour (Fig. 200), since it arises by the retraction of the serum albumen contained in the preparations. Finally, the cadaver bacilli are discolored by the Gram method, while the anthrax bacilli remain well stained after the completion of this method.

Fig. 200.



Cadaver bacilli with pseudo-capsules, from the spleen of an asphyxiated guinea pig, kept in an incubator. × 500 diam.

Occurrence.—Anthrax occurs in all domesticated animals and in man. The sheep is most susceptible, followed by cattle and horses. Wild members of the deer family and also hare are affected by anthrax. Finally, the disease may be transmitted to fowls (chickens, ducks and geese). The hog is usually resistent toward anthrax infection and shows in this relation a great similarity to man.

Clinical Symptoms.—The clinical symptoms of anthrax vary according to the mode of infection and the susceptibility of the species of animal. Anthrax bacilli enter either by way of the alimentary tract or through the injured skin. Artificial anthrax infection may be produced by rubbing the bacilli into the uninjured skin. Alimentary or intestinal anthrax is always due to a spore infection, for the spore-free bacilli are rendered innocuous by the gastric juice (Koch, Falk). Natural skin-infection, which may also be produced by the bacilli, is connected with the presence of wounds,

Pathologico-anatomical Findings.—The spleen exhibits the most important alterations. It is considerably swollen, blackish-red and of a fluid consistency, if the capsule is incised. Moreover, we observe a tar-like condition of the blood, hemorrhages in all organs, especially under the epicardium, and parenchymatous degeneration of the liver, heart and kidneys. Finally, yellow gelatinous or hemorrhagic infiltration may be present in the subcutaneous, submucous and subserous tissues.

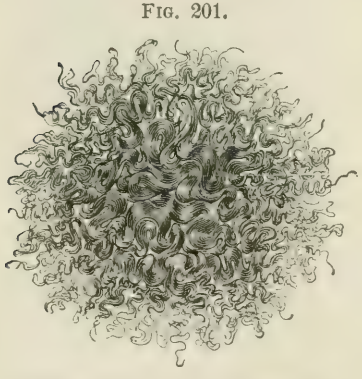
In hogs, anthrax is characterized by decided cervical edema. Swelling of the spleen in anthrax of hogs may be absent.

Diagnosis and Differential Diagnosis.—The following diseases may be mistaken for anthrax:

(1) Malignant edema; (2) petechial fever; (3) hemorrhagic septicemia of cattle; (4) blackleg; (5) sepsis; (6) intoxications; (7) splenic tumors in consequence of metabolic infarcts or torsion of the spleen.

Anthrax, except in the hog, in which animal the bacterial findings in the blood and in the pathologically-altered foci is decisive, is distinguished from all these diseases by the characteristic splenic tumor, as well as by the finding of numerous non-motile and morphologically well-characterized rods in the spleen. In acute anthrax in cattle and horses and in anthrax of hogs, the bacilli in the spleen may not be numerous. In such cases the mesenteric glands ought to be examined in cattle and horses (Fiorentini), and the edematous infiltrated areas of the subcutis in hogs, for the purpose of detecting the presence of the anthrax bacilli. In doubtful cases, animal experiments and bacteriological cultures must decide. The anthrax bacillus kills mice, as a rule, within thirty-six hours; guinea pigs and rabbits within forty-eight hours. In plate cultures, one observes, after twenty-four to thirty-six hours, by a slight magnification, quite characteristic colonies which are formed of bundles of anthrax threads "like locks of hair" (Fig. 201). It should be noted that for the differentiation of the anthrax bacilli

Fig. 201.



Anthrax colony from an agar plate culture 24 hours old.
× 35 diameters.

from edema bacilli inoculation of mice is not sufficient, since, strangely enough, in mice, edema bacilli occur also in the blood. Furthermore, attention may be called to the fact that the virulence of anthrax bacilli is weakened by putrefaction, and, in fact, may be entirely destroyed. A negative result from inoculation with putrefying blood from suspected carcasses can not, therefore, be considered as proof of the absence of anthrax.

With reference to metabolic infarcts in the spleen in consequence of torsion of this organ, attention has already been called (page 347) to the fact that this may lead to a quite considerable increase in the volume of the spleen. This increase in volume, however, is distinguished from anthrax tumor by the pronounced firm character. A fluid condition of the spleen, such as exists in anthrax, never occurs. The metabolic infarcts, moreover, are distinguished by their conical contours. Furthermore, we may demonstrate the emboli directly, in the branches of the splenic arteries.

Procedure With the Meat of Anthracic Animals.—Sec. 31 of the Imperial law of June 23, 1880, and May 1, 1894, concerning the prevention and suppression of animal plagues, prescribes that "animals which are affected with anthrax or suspected of being affected with this plague, shall not be slaughtered"; and Sec. 33 of this law declares that "the carcasses of dead or slaughtered anthracic animals or of animals suspected of being affected with this plague must be immediately rendered innocuous. The skinning of these animals is forbidden."

This measure is primarily dictated by veterinary police considerations. How shall we judge the meat from a sanitary police standpoint? Is the meat of animals affected with anthrax injurious to health?

Forensic Judgment of the Meat of Anthracic Animals.—Bollinger has already called attention to the fact that anthrax is not so easily transmitted to man by the consumption of meat as has been generally assumed. Accordingly, he combated the former general assumption (Heusinger) that, as a rule, cases of meat poisoning are to be ascribed to the consumption of meat of anthracic animals. Bollinger's view has received extensive confirmation by recent observations. It has been repeatedly shown that in cases of emergency slaughter of anthracic animals, the consumers, sometimes numbering hundreds, remain well, while the butchers who injure themselves during the slaughtering become affected with anthrax.

Thus, Behring described a case in which the meat of a bull, subjected to emergency slaughter on account of anthrax, was eaten without any harm, while the butcher and his mother, who assisted at the slaughter, contracted malignant pustule. Similar cases may be cited in large numbers. Mayer reported concerning an enzootic of anthrax in Alsace in which five diseased cows were utilized as human food. Thereupon, in one village nine persons who had come in contact with the raw meat, took sick. Of this number, two died with pustules on the thumb or arm and the remaining patients had pustules on the hands. "Of the numerous persons who had eaten the meat, only three became affected, and they recovered."

Accordingly, the meat of anthracic animals ordinarily produces no injurious consequences after being eaten, and this experimental fact is sufficiently explained by the biological peculiarities of the anthrax bacilli. As already explained, no spores develop in the meat or by ordinary methods of preservation in cool places, even upon its surface. Spore-free anthrax bacilli, however, are destroyed by the secretions of the stomach.

Resistance of Anthrax to Higher Temperatures.—Anthrax bacilli are destroyed by heating to a temperature of 55° to 60° C. for ten to fifteen minutes. For the destruction of the spores, on the other hand, a boiling temperature for several minutes is required.

Although experience teaches, and science has given us a perfectly satisfactory explanation of the fact, that the meat of anthracic animals, as a rule, does not produce harmful results after being eaten, it must, nevertheless, be treated as a dangerous food material, quite aside from the stringent provisions of the Imperial Animal Plague Law. For,

1. The possibility of infection from meat which contains only the bacilli is not excluded, if there are lesions in the mouth, pharynx and esophagus of the consumers.

2. Under especially favorable external conditions, as shown by Schmidt-Mülheim, spores may form on the surface of the skinned carcasses (high external temperature during the preservation of the meat in badly ventilated rooms), whereby exceptionally an intestinal infection may be produced.

3. It should not be forgotten that anthracic meat which contains only bacilli may produce an infection by mere handling; for example, during the process of cutting up, if the persons thus engaged have lesions on their fingers. Thus, for example, in

Germany, between 1886 and 1890, 363 human beings were affected with the skin form of anthrax. They were mostly butchers, knackers and other persons occupied with the slaughtering, skinning and burning of animals. Among the 363 human cases of anthrax, not less than 187 were butchers and knackers. In 1894 there were 109 cases of the transmission of anthrax to man in Germany, with 14 fatal terminations; in 1896, 82 cases, with 15 fatal terminations; and in 1900, 62 cases, 10 of which died.*

Concerning primary intestinal anthrax in man, Baumgarten states, "the second form under which human anthrax appears is the primary intestinal anthrax which was formerly known as mycosis intestinalis. Bollinger, and especially E. Wagner, deserve credit for having referred to the forms of anthrax this previously much observed but not thoroughly understood disease. Later observations completely confirm the views of these authors. The majority of cases have been observed in persons who work on animal skins, especially in the preparation of animal hair. In a case of this sort, E. Wagner succeeded in microscopically demonstrating, on the hair, spore-bearing rods which were identical with anthrax bacilli. The origin of the infection was thus discovered. The anthrax spores passed from the fingers to the food, thence into the stomach and from thence into the intestines of the patient."

Appendix.—Perroncito reported as follows concerning a disease resembling anthrax: In Sardinia a peculiar epizootic disease prevails among horses, asses, cattle and hogs, and is transmissible to man. Of the various experimental animals, rabbits, guinea pigs and fowls are susceptible. The disease in question closely resembles anthrax in its course and clinical symptoms, but sometimes appears also under the form of hematuria or hemoglobinuria. Perroncito believed that he had found *Proteus virulentissimus* as the microorganism which caused this disease. Probably the disease investigated by Perroncito was the hematuria of Sardinian cattle, in which Sanfelice and Loi demonstrated piroplasma to be the cause of the disease (page 537).

* A case which is very instructive in regard to traffic in anthracic meat occurred in the Swiss village of Gex. Of the 360 to 460 persons who ate of the meat of an anthracic beef animal in that town, only one, a woman who received an injury on the forearm in cutting up the head of the animal, became affected with the disease. A dog which had gnawed a raw bone became infected. The anthrax infection in the dog took place on the nose, and, without doubt, from a wound which the dog received while fighting with a cat over the bone.

(b) Aphthous Fever.

Aphthous fever possesses great interest for experts in the practice of meat inspection, notwithstanding the fact that from a sanitary police standpoint it plays only an insignificant rôle. Aphthous fever is extensively disseminated by food animals, and this brings it about that many larger cattle yards and abattoirs become permanently affected. Since abattoirs are to such a great extent exposed to the danger of infection by aphthous fever, expert inspectors should give careful attention, for veterinary reasons, to this disease, both before and after slaughter.

Occurrence.—Aphthous fever is a disease peculiar to hoofed animals. Occasionally it is said to be transmitted to cats and fowls. Cattle and hogs are most frequently affected with the disease, while sheep are more rarely affected. Horne reported also concerning the appearance of aphthous fever among reindeer in northern Sweden.

Etiology.—Despite numerous investigations, it has not yet been possible to demonstrate the organism of aphthous fever. Klein in London several years ago believed he had found a specific diplococcus in cases of this disease. This finding, however, has not been substantiated. Siegel considered very delicate rods 0.7 μ in length, which he succeeded in isolating from the cadavers of human beings dead of "mouth disease," as identical with the organism of foot-and-mouth disease, but he was unable to identify these rods in case of the latter disease. Siegel later saw his error and acknowledged it. Finally, Schottelius reported that in punctate hemorrhages of the epicardium in a cow which suddenly died of aphthous fever he found a peculiar organism in the contents of aphthæ when certain precautions were observed. This organism was said to grow slowly in colonies of a remarkable character. The colonies contained short and long series of very different sized, roundish bodies which, as a whole, were spherical, of which, however, many, especially those which were located on the ends, showed evaginations which in form resembled motile pseudopodia of the white blood corpuscles. Schottelius called these structures streptocytes in order to distinguish them from streptococci. When injected with 1 cc. of a bouillon culture of eight days' growth, calves and young cattle showed a slight fever after twelve hours, a diminution of appetite and a cough, phenomena which persisted for two or three days.

Aphtha, however, did not appear and hogs utterly failed to react to inoculations of streptocytes. Kurth corroborated the finding of Schottelius. Kurth was unable, however, to produce aphthous fever artificially by inoculation with "*Streptococcus involutus.*"

The most comprehensive investigations concerning the organism of foot-and-mouth disease during the last ten years were made by Löffler, Frosch and Uhlenhut in the Berlin Institute for Infectious Diseases and later in the Hygienic Institute at Greifswald, as well as in connection with a Commission in the Imperial Health Office in Berlin. The skill and industry of these investigators, however, did not suffice to clear up the mystery which prevails with regard to the etiology of foot-and-mouth disease. The investigations in question, on the other hand, produced important results with regard to the nature of the infectious material. Attempts to infect the smaller experimental animals with foot-and-mouth disease resulted negatively. Mice, guinea pigs, rats, rabbits, chickens, pigeons and ducks were refractory. Goats also exhibited no pronounced symptoms of disease, in spite of the fact that they were inoculated with large quantities of very virulent lymph. Two goats developed slight granulations at the point of inoculation. The hoofs, however, remained wholly unaffected. Attempts to produce artificial infection in sheep in a typical manner were unsuccessful. Cattle and hogs reacted equally well to the infection.

In the Institute for Infectious Diseases it was found possible to transmit the disease to calves by means of the blood of animals which had been inoculated twelve to twenty-eight hours previously and had exhibited a rising fever. It was not found possible to produce infection by means of feeding muscle meat, pieces of the spleen, liver, kidneys or contents of the intestines, but positive results were obtained by feeding the affected parts of organs.

The contents of aphthæ which were heated for fifteen minutes to a temperature of 50°, ten minutes to 70° and momentarily to 100° C. lost their virulence. In the Institute for Infectious Diseases the contents of aphthæ were found to be still infectious after heating for half an hour to 50° C.

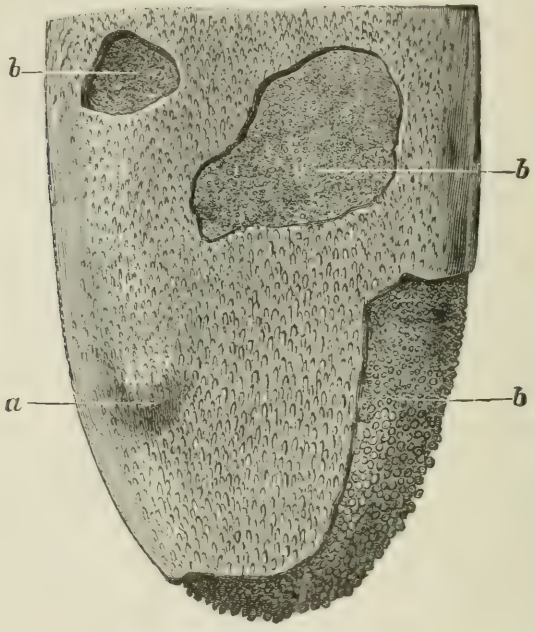
The virus of foot-and-mouth disease is not influenced by cold. Lymph placed in a mixture of chloride of lime and ice and kept in a frozen condition (— 48° C.) for about three hours, promptly infected the inoculated animals.

The contents of aphthæ, on the other hand, appear to possess only a slight resisting power against desiccation, since lymph which was dried on a sterilized plate in a desiccator over sulphuric acid

in vacuo at a temperature of about 22° C. for eighteen hours did not produce disease in the inoculated animals. Lymph which was dried on wood, stones and flannel at the living temperature and under diffuse sunlight likewise became inactive after twenty-four hours.

Lymph also proved to have but little resisting power against disinfectants. It was found possible to destroy its virulence by an exposure for one-half hour to the following solutions in the strengths

FIG. 202.



Aphtha. Tip of beef tongue.
a, Aphtha; *b*, epithelial erosion after bursting of the aphtha.

indicated: Carbolic acid, 1 per cent.; formaldehyde, 2 per cent.; soda, 3 per cent.; hydrochloric acid, 1 per cent.; phosphoric acid, 1 per cent.; milk of lime, 1 per cent. An interesting observation was made in filtering diluted lymphs through a Chamberland filter. It was found that the filtrate remained infectious.

Finally, in artificial transmission experiments, it was found by the Commission that the incubative period up to the outbreak of the fever was from one-half a day to six days, and up to the eruption of aphthæ, it was from two to ten days.

Diagnosis.—Vesicles filled with a clear fluid (aphthæ, see Fig. 202, *a*) constitute the characteristic symptoms of aphthous fever. They appear in cattle most frequently on the nasal septum and on the toothless border of the upper jaw as well as on the tip and lateral surfaces of the tongue and on the mucous membrane of the cheeks and hard gums (mouth disease). When aphthæ are present on the border and in the cleft of the hoofs, one speaks of foot disease. Aphthæ are also observed on the udder and rarely in the pharynx, at the base of the horns and on the mucous membrane of the external genital organs.

In hogs, aphthæ are far more numerous on all four toes than on the head. Aphthæ are also comparatively frequent on the tip of the snout.

Aphthæ persist for only a short time. They soon burst and leave behind a watery erosion. These erosions, as a rule, heal very quickly by proliferation of the epithelium or epidermis from the side. Previous to their healing, they are recognizable by the sharply-marked limits between the sound tissue and the eroded areas, which result from the bursting of the aphthæ (Fig. 202, *b*). It should be observed that the erosions on the hoofs, especially of hogs, are characterized by a tendency to hemorrhages. Moreover, the sloughing-off of the hoofs is not a rare occurrence in hogs, in consequence of hoof disease.

Differential Diagnosis.—The sequelæ of aphthæ in the mouth cavity may be confused with erosions following chemical or thermic agents, but especially with actinomycotic erosions; and, on the toes, they may be confused with, for example, simple traumata. Such confusion is not possible when intact aphthæ are present. Actinomycotic erosions, which are not infrequent on the mucous membrane of the cheeks and tongue of cattle, may be easily distinguished from aphthous erosions. For the former, in contrast with the latter, are sharply delimited and possess a tough, leathery basis with punctate, depressed, yellow areas. In case of actinomycotic erosions, the fungiform papillæ are destroyed; these remain unaffected in aphthous fever (Leutsch).

Simple traumata on the hoofs, which, especially in hogs, have led to confusion with foot-and-mouth disease, commonly affect only one toe, and, furthermore, are not restricted to a shedding of the epidermis, as is the case in bursted aphthæ; but they attack deeper-lying parts in cases where they become noticeable at all.

In sheep so-called foot rot is frequently mistaken for foot-and-mouth disease. In case of foot rot there is an inflammation of the epidermis of the cleft of the hoof, in which, however, aphthæ are absent.

Judgment.—Parts of diseased animals affected with aphthæ and fresh erosions must be regarded as dangerous food material in a raw condition, for aphthous fever is transmissible to man. The meat, on the other hand, as well as all other parts of aphthous animals, possesses, according to experts, no injurious properties. It is, therefore, a common practice to remove from these animals only those parts which form the seat of specific alterations. All other parts, however, are admitted to the market as suitable food material.

With regard to parts of the body affected with aphthæ and erosions, the usual procedure is not strictly correct. Some expert inspectors consider it sufficient to cut out the diseased parts and admit the rest of the organs to the market. Other inspectors order the total destruction of these organs. The one procedure is as unworthy of approval as the other. The diseased parts are conditionally utilizable. They may be admitted to the market after they have been scalded in boiling water, for the boiling temperature destroys the virus of aphthous fever, and by scalding, such valuable parts as the tongue may be saved for use as food.

Sequelæ and Sudden Fatal Cases of Aphthous Fever.—Judgment in the case of sequelæ should be essentially different from that in cases of aphthous fever. Chiefly in cattle, less frequently in hogs, chronic suppurative processes, as a result of aphthous fever, develop in the hoofs, hoof joints and udder, and may lead to pyemia. In such cases, not only the diseased parts, but also the whole musculature may acquire dangerous properties if the symptoms of pyemia are present (see page 561).

In general, aphthous fever runs a benign course, if we disregard the sequelæ. Sudden fatal cases may occur, however, in consequence of the disease, the origin of which is not fully understood (malignant foot-and-mouth disease). Lydtin observed fatal cases in consequence of aspiration of sloughed-off shreds of epithelium from the mouth and pharyngeal cavities. Other authors observed these results after aspiration of masses of food during rumination. In both cases death occurred from asphyxiation.

The meat of such animals is, therefore, to be treated like that of asphyxiated animals.

For the present we have no certain criteria for deciding how to judge the meat of animals in which multiple embolic myocarditis (numerous grayish-red and grayish-yellow spots, especially in the myocardium of the left ventricle) is found to be the cause of death (Johne). I have been unable either by personal inquiry or by examination of the literature to find any injury to health from eating such meat. From the reports of the Bavarian District Veterinarians it would appear that the meat of animals subjected to emergency slaughter on account of unfavorable symptoms is regularly eaten without injury. These veterinarians emphasize the fact that the meat in question, as a rule, showed no alteration. Loffler was able to kill hogs by injecting large quantities of the contents of aphthæ, whereby an embolic myocarditis, resembling that which is found in cattle dead of malignant foot-and-mouth disease, was found to be a most striking phenomenon.

In reference to the skins of aphthous animals, the instructions for carrying out Secs. 19 to 28 of the Imperial Plague Law prescribe as follows: "Skins of dead or slaughtered diseased animals may be removed from the quarantine limits only in a completely dried condition, except in cases where they are delivered directly to the tannery."

Since in the case of cattle it is customary in slaughtering to leave portions of the skin connected with the feet, the latter are subject to the same trade restrictions as the skins of aphthous animals.

(c) Pox.

In domesticated animals, two independent pox diseases occur: cow pox and sheep pox. Cow pox as well as sheep pox may be transmitted to man by subcutaneous inoculation.

Cow Pox.

Spontaneous cases of cow pox possess no sanitary police interest, since they represent benign local affections which never lead to the slaughter of the affected animals. The conditions are different, however, in the case of calves and bulls, in which pox is produced for the purpose of obtaining vaccine. These animals are slaughtered after removing the vaccine material for the purpose of determining the condition of their health.

JUDGMENT.—The meat of vaccine calves and bulls in most abattoirs is admitted to the market after the removal of the edematous infiltrated subcutis under the point of inoculation. No harm from eating such meat has ever been observed.

In contrast with this practice, Goltz urges that vaccine calves shall not be slaughtered until after the inoculation disease has run its course. Otherwise, he argues, the meat should be sold on the freibank. Goltz bases his view on the following facts: (1) Vaccine calves, at the time of the removal of the vaccine, exhibit a feverish condition; (2) the disease is transmissible to man; (3) swellings are observed in the skin and subcutis as well as in the corresponding lymph glands of the point of inoculation. Even if pox is not transmissible by the consumption of the meat, it should not be forgotten that the meat may be contaminated with pox virus in the process of cutting up.

According to the author's view, the sale of the meat on the freibank is justified only in the case of such vaccine calves as show a temperature of over 40.5° C. at the time of the removal of the vaccine, or have lost weight in consequence of accidental intestinal catarrh. With rational feeding, vaccine calves increase in weight during vaccination. Contamination of the meat with the pox virus during slaughter may be prevented by previous disinfection of the points of inoculation, preferably by the vaccine physicians after the vaccine has been taken.

Sheep Pox.

Sheep pox is without significance in Germany for the reason that this disease has been exterminated by the operation of the Imperial Animal Plague Law of Germany (prohibition of sheep pox vaccination). Merely the malignant form of sheep pox, in which the so-called cadaveric and gangrenous pox arises, would be of interest in meat inspection, since animals affected with the benign form are not usually brought to slaughter.

JUDGMENT.—The meat of animals affected with benign pox is to be treated in different ways, according to the stage of the disease: In the eruption and maturation stage of the disease as a spoiled or inferior food material; in the healing stage, however, with the animal in a good nutritive condition, as a marketable food material.

In cases of cadaveric and gangrenous pox, however, which, especially in very young and very old animals, often leads to the

development of fatal cases of sepsis, the meat, like that of all food animals suffering with septic disease, is to be considered as a dangerous food material. The following regulations of the instructions of the Imperial Animal Plague Law refer to the skins of variolous sheep:

Section 97[10]. "Skins of dead or slaughtered variolous sheep may be removed from the quarantine limits only in a completely dried condition, except in cases where they are to be delivered directly to the tannery."

(d) Rabies.

General.—Rabies possesses quite subordinate importance for meat inspection. The official reports concerning the distribution of animal plagues make mention each year of rabies in cattle, sheep and hogs. The number of these cases, however, is always very small.

The Etiology of rabies is thus far unknown.

Diagnosis.—For the diagnosis of rabies in food animals, the history, especially the determination of a previous dog bite, is of importance. For the rest, the negative pathologico-anatomical findings and the presence of indigestible material in the stomach is characteristic of rabies. A certain diagnosis is made possible only by subdural, intraocular or intracerebral inoculation of cerebral substance (pons varolii) into rabbits. With intracerebral inoculation, the incubative period, as shown by Leclainche and Morel, is shorter than with subdural or intraocular inoculation. The histological diagnosis of rabies, recommended by Babès, Van Gehuchten and Hélis (pericellular accumulations of leucocytes in the medulla and especially in the plexiform ganglion of the vagus), is not reliable, since it may fail in the case of animals killed during the progress of the disease.

Judgment.—The transmission of rabies by eating the meat of rabid domesticated animals has never been observed. Nevertheless, the meat of rabid animals is to be absolutely excluded from the market, since infection may arise in cutting it up. In Copenhagen, in 1857, a veterinary student with a wound on his finger did a post mortem examination on a dog dead of rabies, and died; a few years ago a similar case occurred with a student in Dresden in conse-

quence of an injury received during a post mortem examination of a rabid dog. It should be remembered in this connection that the virulence of the most important carriers of rabies virus, the central nervous system and salivary glands, does not disappear, as previously assumed, within twenty-four hours, but, according to von Ratz, only after fourteen to twenty-four days. The Russian veterinarian, Wyrsykowski, instituted careful experiments concerning the action of the gastric juice on the virus of rabies. Proceeding from the fact that after eating the meat and even the brain of animals dead of rabies no illness occurred, Wyrsykowski tested the action of artificial gastric juice upon the medulla oblongata of an affected rabbit, in a thermostat. Of twenty-one rabbits which were inoculated with artificially-digested rabies virus, none contracted rabies, while seventeen control animals, inoculated with undigested virus, died of the disease.

The Imperial Animal Plague Law prohibits the slaughter of rabid animals and animals suspected of rabies, as well as all traffic in the meat.

Sec. 36: "The slaughter of rabid animals or animals suspected of being rabid and the sale or utilization of individual parts, milk, or other products of such animals, is forbidden."

Sec. 39: "The carcasses of slaughtered rabid animals or animals suspected of being rabid must be immediately rendered innocuous. The skinning of such animals is forbidden."

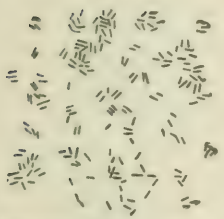
(e) Glanders.

Nature and Occurrence.—Glanders is an infectious disease of solipeds (horses, asses and their crosses, mules and hinnies). The typical symptom of this disease is the appearance of tubercles which are caused by the entrance of specific bacilli (the glanders bacilli). In consequence of the disintegration of the tubercles, ulcers arise on the mucous membrane. In the parenchymatous tubercles the disintegration is characterized by a cloudiness which progresses from the center outwards. During this disintegration, hyperemia and cellular inflammation occur in the surrounding tissue. Calcification of the glanderous tubercles has not been observed (Csokor, Hahn, Kitt, Schütz). A specific affection of the corresponding lymph glands is associated with the tubercles and ulcers. Glanders is communicable to cats, dogs, and goats as well as to man. Sheep are less susceptible. Hogs are nearly refractory and cattle are entirely immune. Among the experimental animals,

field mice and guinea pigs react very promptly to inoculations. In zoological gardens, glanders has frequently been observed in carnivorous animals after feeding on glanderous horse meat.

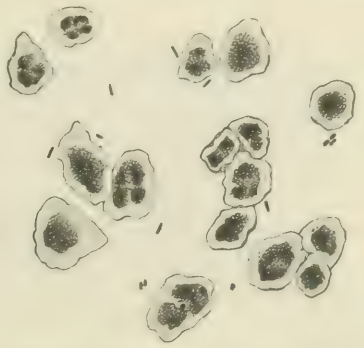
Bacteriology.—Glanders is produced by the glanders bacilli which were discovered by Löffler and Schütz. They are non-motile, short and thicker than the tubercle bacilli (Fig. 203). They may, however, grow into threads and form lateral branches. For this reason the organism of glanders has been classed with the fungi (streptothrices), or with the group of actinomyces bacteria. The formation of spores has not been demonstrated. Glanders bacilli are best stained in an alkaline or carbolized solution of methylene

Fig. 203.



Glanders bacilli from a young potato culture. × 500 diameters.

Fig. 204.



Smear of glanderous pus from the inguinal gland of a guinea pig, with unusually numerous bacilli. The nuclei of pus cells have split up into numerous small spherules. × 500 diameters.

blue. A specific staining method for the glanders bacilli has not been perfected, in spite of numerous efforts in that direction. We are, therefore, not in a position to demonstrate glanders as we may tuberculosis, simply by staining the bacilli, since the glanders bacilli are without morphological peculiarities. Pure cultures and inoculation, however, give more reliable criteria for identification. Cultures of glanders bacilli on potato exhibit a honey-like layer after two days, which in six to eight days becomes opaque and at the same time assumes "a color resembling the red of cuprous oxide." (According to Löffler, the somewhat similar yellowish-brown potato cultures of green pus are distinguished by the fact that small quantities smeared on filter paper and exposed to the

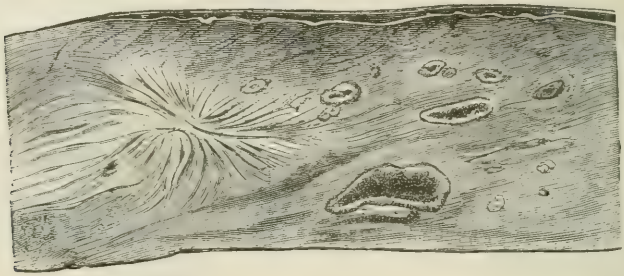
fumes of ammonia immediately turn bluish-green, while cultures of glanders bacilli remain unchanged.)

The glanders bacillus offers but slight resistance to disinfectants. Water at a temperature of 55° C. kills it after an exposure of ten minutes.

The glanders bacilli are found chiefly in the pathologically altered parts. They are not always found in the blood, and, as a rule, only in small quantities. Even in the specifically-altered foci, the number of glanders bacilli demonstrable by staining is usually small.

A highly important and remarkable fact in the diagnosis of glanders was demonstrated by Unna and confirmed by Schütz, namely, that the cell nuclei in the glanderous foci become dissolved

Fig. 205.



Nasal septum of horse with glanderous ulcers and a cicatrix.

in a remarkable manner (dissolution of the nuclei, chromatotexis, according to Unna). Schütz also demonstrated that the chromatin of the nuclei of the round cells in the glanderous foci is not destroyed, as in other mortifying processes, but is preserved even when the nuclei are completely disintegated. The nucleus first breaks up into four parts which lie close together and form a small mass of nearly the form of the nucleus (Fig. 204). Later the individual granules become separated from the nuclear mass and are distributed in the protoplasm of the cell, or the nuclear mass is disintegrated and distributed uniformly in the cell substance. The nuclear débris retains all the properties of the nuclear substance, especially its affinity for stains.

During Life.—The most important alterations in chronic glanders, and those to which meat inspectors should give chief attention in the examination before slaughter, are the following:

The glanderous tubercles in and under the skin, the characteristic farcy ulcers of the skin, indolent phlegmons on the extremities and head, ushered in with the formation of ulcers, typical swelling of the lymphatic vessels and glands, and, finally, glanderous tubercles, ulcers and scars which are observed upon an inspection of the nasal cavities.

Anatomical Findings.—We may first emphasize in this connection the fact already mentioned on page 157, that in cases of glanders it is absolutely necessary to dissect the head and make a careful examination of all parts of the mucous membrane of every slaughtered horse. The laryngeal lymph glands of all slaughtered horses should also be subjected to a detailed examination. In addition to the alterations which are demonstrable during life on and under the skin and in the inferior third of the nasal cavities, the specific alterations in the accessory cavities of the nose, in the guttural pouch, and in the larynx and trachea are present in cases of chronic glanders. In the great majority of cases of glanders, the lungs are also affected. In 52 cases examined by Bollinger, the lungs were found affected in only 4 cases, and in only 10 of the 216 post mortem examinations made in the Berlin High School. The lungs are permeated either with embolic glanderous tubercles, or with infiltrations varying in size from a walnut to a child's head, the so-called glanderous growths. Furthermore, embolic glanderous foci, as a result of glanders of the skin or respiratory apparatus, may appear in other organs, especially in the spleen, liver, kidneys, testicles, brain, heart muscles and bones.

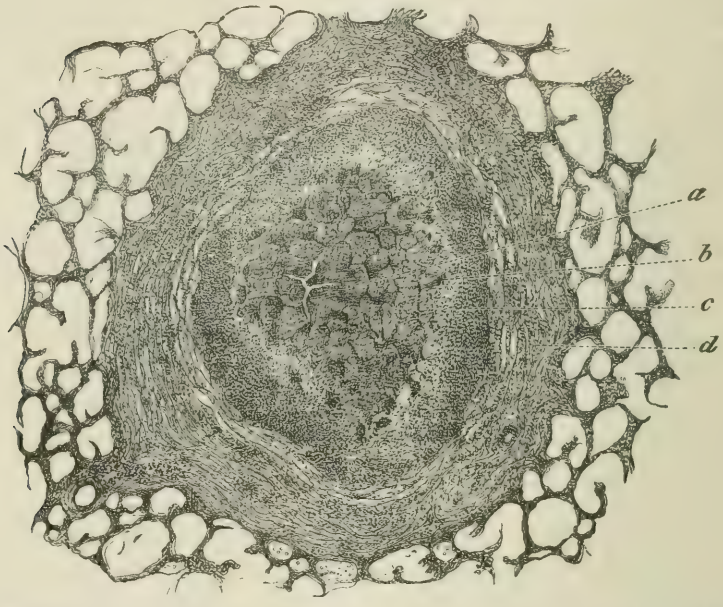
Diagnosis.—The diagnostic characters of the glanderous tubercles are the grayish, transparent, glassy appearance, the red area as well as the sympathetic affection of the corresponding lymph glands (swelling and glanderous tubercles on the cut surface). The glanderous growths in the lungs are distinguished from all other similar alterations by their diffuse grayish-white, soft or firm character, and the uniformly constant affection of the bronchial glands.

Differential Diagnosis.—The number of diseases which may be and have already been confused with glanders is quite large. Especial mention should be made of contagious coryza, leukemia, croupous rhinitis, chronic catarrh of the nose, non-glanderous pulmonary tubercles and botryomycosis of the lungs. The positive

differentiation of these processes from glanders should not be difficult for the expert inspector, if attention is given to the characteristic symptoms of glanders in slaughtered animals.

In doubtful cases, the question must be decided by a bacteriological test. In intact farcy buds and in diseased lymphatic glands, we may make a reliable bacteriological diagnosis, since in these parts the glanders bacilli are present in pure cultures. Moreover, in these cases, all doubt may be removed by making a culture on potatoes. The diagnosis is not so easy when the material is con-

Fig. 206.



Old glanderous pulmonary tubercle. *a*, central necrotic portion; *b*, giant cells; *c*, boundary between necrotic portion and capsule with chromatic remains of disintegrated giant cells; *d*, connective tissue capsule. × 30 diameters.

taminated (secretion from ulcerous broncho-pneumonic foci, etc.). In such cases experiments on animals are indispensable, and such experiments should be made preferably on guinea pigs, since field mice frequently die of intercurrent septicemia. Formerly male guinea pigs were used almost exclusively for inoculation, since the affection of the testicles, which may appear in the second week, was considered a good means of recognizing glanders. At present intraperitoneal inoculation of female guinea pigs is recommended

(Besnie). It is stated that in these animals a purulent discharge takes place from the vagina after two days. According to Strauss, purulent orchitis appears in male guinea pigs after two days when the animals are inoculated intraperitoneally and not subcutaneously.

Histology of Pulmonary Glanderous Tubercles and their Differentiation from Entozoic Pulmonary Tubercles.—According to Schütz, recent embolic glanderous tubercles in the lungs of horses represent pneumonic foci about the size of grains of sand which are reddened and not sharply delimited, but which shade off gradually into the healthy neighboring tissue. The center of the glanderous tubercle, in consequence of mortification of the cellular exudation in the alveoli and the lung tissue in them, soon becomes cloudy and is not round, but is furnished with projecting processes, or is sometimes wedge-shaped (Fig. 206, *a*). The central part of the tubercles is always sharply delimited from the more deeply reddened periphery. A section through quite recently developed glanderous tubercles shows in the center as well as on the periphery a granulated character (miliary fibrinous pneumonia). In older glanderous tubercles, the granulation disappears in consequence of the necrosis of the pneumonically-altered parts. The center becomes smooth, dry and grayish-yellow and around the center a transparent gray capsule is formed (Fig. 206, *d*). The center of glanderous tubercles consists of a peculiar detritus, which can not be compared either with pus or with cheese and takes an unusually deep stain on account of the abundance of chromatin. Calcification is wanting. On the border between the central necrosed portion of the glanderous tubercle and the capsule, giant cells and plasma cells are found (Unna), both of which are characterized by their unusual size. In fresh glanderous tubercles, the giant cells and also the plasma cells are wanting. Later, the giant cells disintegrate, while the dissolved chromatin persists (Fig. 206, *c*).

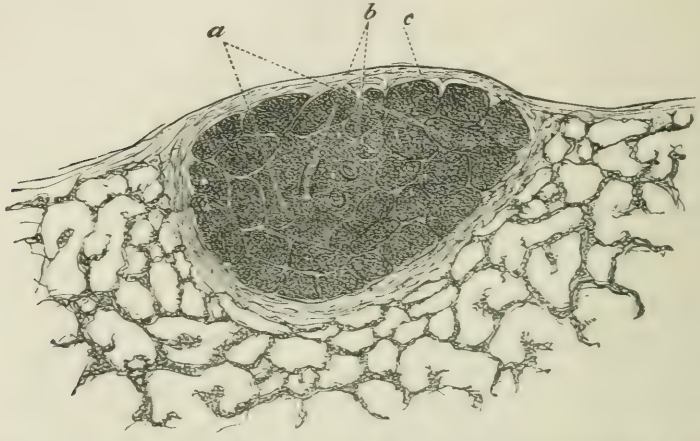
According to Schütz, entozoic pulmonary tubercles (compare page 328) are caused by parasites which penetrate into the capillaries or remain lying in the larger vessels of the lungs. In the first case a chronic miliary pulmonary inflammation arises and in the second a chronic inflammation of the vascular walls with obturating thrombosis.

Tubercles of the first form consist of infiltrated alveoli and a delicate capsule. The center of the tubercles is formed almost exclusively of cellular tissue and in it a parasite is to be demon-

strated (Fig. 207). After the death of the parasite, it first becomes calcified and, later, also the whole tubercle, with a thickening of the connective tissue membrane. The tubercles possess a diameter of 1.5 to 3.5 mm., and the parasites in them possess a diameter of 42 to 81 μ.

Entozoic tubercles of the second sort are composed of a capsule and the plug. The capsule is formed by the thickened vascular wall and is usually strengthened by the chronically-inflamed neighboring pulmonary tissue. The central plug is a thrombus which incloses the parasite and may either calcify or soften. In softened tubercles the parasite is less frequently demonstrated

FIG. 207.



Entozoic pulmonary tubercles of a pneumonic form in the horse (after Olt). *a*. inflamed alveoli; *b*. part of a nematode larva; *c*. connective tissue capsule of the parasitic focus. × 30 diameters. The parts of the worm are magnified 80 diameters.

than in calcified ones, since in the former case it rapidly disintegrates in consequence of fatty metamorphosis.

In the differentiation of glanderous tubercles from entozoic tubercles, it is important to note that in glanders, recent tubercles in various stages of development regularly occur in addition to the old glanderous tubercles.

PSEUDO-GLANDERS.—Nocard isolated from horses suspected of being affected with the skin form of glanders a pseudo-glanders bacillus. By means of intraperitoneal inoculation it was distinguished from the true glanders bacillus by the fact that it could be stained by the Gram method, killed mice in from 24 to 48 hours,

with the formation of an abscess at the point of inoculation, and produced in horses only local abscesses and not glanders.

JUDGMENT.—Sec. 43 of the Imperial Animal Plague Law contains the following regulation relative to glanders: "The carcasses of dead or slaughtered glanderous animals must be immediately rendered innocuous. The skinning of such animals is forbidden."

This provision renders superfluous for the practice of meat inspection all further discussion concerning the harmful or harmless character of the meat of glanderous animals. It is of scientific and forensic interest, however, to discuss the question whether glanders may or may not be communicated to man by means of the meat of glanderous animals. It has already been mentioned that carnivorous animals in zoological gardens have frequently contracted glanders in consequence of being fed upon the meat of glanderous horses. A similar infection in man has not yet been observed with certainty. In fact, it has been shown in many cases that the meat of glanderous horses has been eaten by man without harm; as, for example, during the siege of Paris (Decroix).

Baumgarten ascribes the different reaction of man and carnivorous animals to the consumption of the meat of glanderous horses to the fact that the latter in masticating the bone connected with the meat receive wounds in the mouth cavity and thus become infected; for primary intestinal infection appears not to occur in any animal, since specific glanderous affection of the intestinal wall has thus far never been observed. This assumption can, however, no longer be maintained since the recent investigations of Nocard, which have been confirmed by Schütz. For, in these investigations it was shown that primary intestinal glanders could be produced by feeding glanders bacilli. Moreover, the danger of infection from glanders exists both in masticating bones and in merely handling glanderous meat, whether wounds are already present or are received from projecting bone splinters. For this reason the meat of glanderous animals must be considered as a dangerous food material.

(f) Tuberculosis.

1.—NATURE AND OCCURRENCE.

Tuberculosis is a chronic infectious disease, which is caused and disseminated by the tubercle bacillus. It is the most frequent

disease of food animals and, next to septicemia, is their most important disease from a sanitary standpoint. Tuberculosis occurs in all our domesticated animals. With regard to the frequency of the disease in different species of domesticated animals, however, a striking difference prevails. While the cases of tuberculosis among horses and sheep must be considered as exceedingly rare, tuberculosis is a frequent disease in hogs and a regular plague in cattle. With regard to the goat, it was formerly assumed that this animal was free from tuberculosis. Inoculation experiments, however, and more careful investigations at abattoirs have shown this view to be untenable.

The frequency of the occurrence of tuberculosis in the two domesticated animals which are most affected varies within wide limits, according to the origin of the animals. Thus, in southern Germany, tuberculosis of hogs was formerly very rare, while even in the 70's Schütz said of northern Germany, "tuberculosis in hogs possesses a scarcely-suspected distribution, as I have learned, partly from the reports of district veterinarians and partly from personal experience." At present tuberculosis of hogs is observed more frequently also in southern Germany, but by no means so frequently as in northern Germany. In the latter region the number of tuberculous swine, according to the abattoir reports, ranges from 1 to 7 per cent.

In the case of cattle, such variations in the occurrence of tuberculosis do not exist within the limits of Germany. Cattle which are maintained exclusively on pastures, like the American range cattle, Bukowina cattle and the cattle of the Russian Steppes, are nearly free from tuberculosis.* In stall-fed cattle, according to reliable parties, at least every fourth animal is tuberculous, calves excluded. This proportion is closely in accord with my own experience. The Imperial Health Office, at the request of the Imperial Chancellor, collected statistics concerning the occurrence of tuberculosis in the German Empire. According to these statistics the number of cases of tuberculosis observed in the year 1888–89 in cattle amounted to 0.33 per cent. of a total number of 15,750,000. In the report, however, it was expressly stated that the determined percentage did not at all correspond with the actual conditions, since the statistics were not made upon a uniform basis

* Concerning Australian cattle, it is also asserted they are free from tuberculosis. This assertion, however, is shown to be untrue by an examination of meat imported from Australia. In Leipsic, for example, out of 621 beef quarters imported from Australia five were found to be tuberculous.

(presence or absence of public abattoirs, meat inspection, etc.). The percentages obtained in different parts of the Empire varied exceedingly. While, for example, it was stated that in the "Magdeburg and Brandenburg sugar cattle" almost every fifth animal was tuberculous, in the district of Angermünde no cases were found in 13,000 slaughtered animals; and in the district of Teltov, only 15 cases of tuberculosis were demonstrated in 40,000 slaughtered animals. The percentages obtained, as is emphasized in the report itself, can not lay claim even to approximate accuracy.

A better idea of the distribution of tuberculosis among food animals is obtained from the reports of the different abattoirs.

Frequency of Tuberculosis in Different Species of Food Animals, according to the Showing of the Abattoir Reports.*

(a) *Cattle.*—The percentage of tuberculosis among cattle slaughtered in public abattoirs in different cities for different years ranged between 6.34 and 45.8 per cent.

(b) *Calves.*—Formerly the number of tuberculous calves was found to be extremely small; for example, in the Saxony abattoirs it amounted to only 0.206 per cent. in 1889, .03 per cent. in 1890, and in Berlin .079 per cent. in 1890. At present the percentage of tuberculous calves has increased considerably and ranges, according to reports from slaughterhouses in Germany for different years between .05 and 1.07 per cent.

(c) *Sheep and Goats.*—In both these animal genera cases of tuberculosis are rare. Nevertheless, both sheep and goats are susceptible, as is sufficiently shown by its spontaneous occurrence and by inoculation experiments. In Saxony in 1890, .02 per cent. of the sheep were tuberculous, and in Berlin, during the same year, .0048 per cent. These favorable conditions, however, were found only in sheep and goats living chiefly in the open air. As a result of keeping goats in stalls, they become tuberculous to the same extent as cattle. Eichhorn, for example, reported concerning a herd of goats in Dresden, in which 19, or 68 per cent., were shown to be tuberculous by the tuberculin test. In different parts of Germany for various years the percentages of tuberculous sheep were found to range between .0029 and 1.26.

* The statistical data have been condensed into a much shorter form than in the German original.—TRANSLATOR.

In the Kingdom of Saxony, the percentage of tuberculosis in sheep sank from .15 per cent. in 1894 to .07 per cent. in 1896 and .06 in 1899. This condition is connected with the fact that the pseudo-tuberculous alterations which occur in sheep were formerly sometimes confused in part with true tuberculosis.

The percentage of tuberculosis in goats in different parts of Germany for different years ranged between .41 and 7.7 per cent.

(d) The *Hog*, next to cattle, is most frequently affected with tuberculosis. Swine tuberculosis is, without doubt, as a rule, to be ascribed to feeding the milk of cows suffering from tuberculosis of the udder, or dairy by-products, especially the centrifugal slime of such milk.

Bollinger in the 80's experimentally demonstrated that hogs could be infected by the milk of tuberculous cows and this has been subsequently corroborated by numerous unexceptionable observations. In Hanover, Ströse also observed cases of primary pulmonary tuberculosis in hogs. In various parts of Germany for different years the percentage of tuberculosis in hogs ranged between .21 and 7.7 per cent.

(e) *Horses.*—In different parts of Germany for different years the percentage of tuberculosis in the horse ranged between .08 and 1.6 per cent.

Tuberculosis of the horse may arise in consequence of feeding raw, skimmed milk to colts, or of confining horses of any age in cow stalls. Walther observed a case of tuberculosis in a horse which had been confined for 1½ years in a cow stall and which, on account of a poor appetite, had not been taken out of the stall for six months.

Spontaneous tuberculosis also occurs in the ass (Nocard and Blanc).

(f) *Dogs.*—Among dogs slaughtered in the Kingdom of Saxony in 1895, .25 per cent. were found tuberculous; in 1896, 2.22 per cent.; and in 1899, .21 per cent.

Percentage of Tuberculosis as Affected by the Method of Reporting Cases.—The following figures may serve to indicate the extent to which the statistics on tuberculosis are affected by the accuracy of inspection and notification. In Berlin the percentage increased from 3.5 to 4.0 in former years to 11.5 in 1890, when the slight

cases, restricted to one organ or one lymph gland, were taken into consideration. In Leipsic, the percentage increased from 15 per cent. in 1899 to 22.3 in 1890. Schwaimair found 15.62 per cent. of tuberculosis in Aschaffenburg when he included cases of simple tuberculosis of the lymph glands, and only 10.37 per cent. when such cases were not included.

Increase in the Frequency of Tuberculosis.—From the reports of abattoirs the fact becomes evident that tuberculosis in cattle, calves, and hogs is constantly increasing. For example, in Leipsic the following percentages of slaughtered cattle were found tuberculous: In 1888, 11.1; 1889, 14.9; 1890, 22.3; 1891, 26.7; 1893, 28.14; 1896. 32.93; 1897, 36.4; 1898, 35 5; 1899, 32.93; 1900, 35.29. Similar observations were made in other slaughterhouses; for example, in Berlin, Bromberg, Kiel, Lübeck, Schwerin, Zwickau, etc.

In Schwerin, the percentage of tuberculosis increased from 10.7 in 1886, to 26.6 in 1893; in Bromberg, from 20.7 in 1892–93, to 29.3 in 1899–1900; in Berlin, from 11.5 in 1890–91, to 23.14 in 1899; in Rostock, from 17 in 1895–96, to 24 in 1896–97; in Zwickau, from 26.6 in 1894, to 45.8 in 1899. In calves, the percentage increased in Berlin from 0.16 in 1890–91, to .61 in 1897–98; in Zwickau, from .17 in 1894, to .47 in 1897; and in hogs, the percentage increased in Berlin from 1.16 in 1895–96, to 4.1 in 1899; in Bromberg, from 1.3 in 1892–93, to 3.4 in 1895–96; in Kiel from 3.72 in 1893–94, to 6.51 in 1896–97; in Leipsic, from 1.89 in 1893, to 3.12 in 1900; in Rostock, from 3 in 1895–96, to 4.7 in 1896–97; and in Zwickau, from 1.22 in 1895, to 7.5 in 1897.

The alarming increase in tuberculosis among hogs in different parts of north Germany is connected with the increase of creameries and is caused by feeding the raw by-products of the creamery, especially the centrifugal slime (the Author). Separator milk and buttermilk may also disseminate tuberculosis among calves fed upon these materials. Falk in Madgeburg found all of the hogs fattened by creamery owners and milk dealers to be tuberculous, and in Danzig it was found, soon after opening the abattoir in that place, that hogs coming from different creameries were affected with tuberculosis to the extent of from 60 to 70 per cent. Furthermore, Borgeaud found among young pigs which were fed on centrifugal milk a regular enzootic of tuberculosis during which 2, 3 or more pigs per day died of tuberculosis. After the centrifugal milk was boiled before feeding, no further cases appeared.

Recently, the frequency of tuberculosis among hogs and calves

is beginning to diminish in certain localities. One would not err in ascribing this encouraging fact to the officially-prescribed burning of the centrifugal slime and the gradual increase in the practice of heating the milk before feeding.

In Kiel, during recent years, a constant diminution in tuberculosis among hogs is observed, as shown by the following figures: In 1896–97, 6.51 per cent.; 1898–99, 5.2; 1899–1900, 4.2; and in Zwickau, in 1896, 6.06; in 1897, 7.5; in 1898, 6.52; and in 1899, 3.89 per cent.

In Kiel a diminution in the frequency of tuberculosis in calves has been observed as follows: In 1896–97, 1.31 per cent.; 1898–99, 1.3; 1899–1900, 0.85 per cent. Similar observations have been made at the abattoirs in Bromberg and Danzig.

According to observations which the author made fifteen years ago, as abattoir veterinarian in Berlin, on cattle which came from various parts of Germany (East and West Prussia, Posen, Brandenburg, Silesia, Province of Saxony, Mecklenburg, Schleswig-Holstein), at least 25 per cent. of the older cattle were to be regarded as tuberculous, when incipient cases and those which were restricted to one lymph gland were included. This result agrees perfectly with the observations which the author had occasion to make ten years ago in Stuttgart, as ambulatory clinician.

According to the results of tuberculin tests, it must be assumed that the figures obtained in abattoirs were far below the actual conditions; for Siedamgrotsky tested 259 cattle and obtained a typical reaction in 197, or 76 per cent. In the same manner, Bang and Nocard in Denmark and France found that in many herds the number of reacting cattle amounted to from two-thirds to three-fourths of the total number. Similar conditions prevail in England, Holland, Belgium, Switzerland, and also in all other countries in which cattle are not maintained exclusively on pasture. Moreover, in America it has been demonstrated by tuberculin tests that among stall-fed cattle the large majority is affected with tuberculosis. In Germany, the government district of Posen proves to be most excessively infected. In the Posen district of Schroda, it is said to be a rare occurrence that a post mortem is made on a two to three year old beef animal without finding it affected with the disease and to a striking degree. In the region of Samter, the disease prevails on nearly all estates.

Influence of Age Upon the Frequency of Tuberculosis.—The different classes of beef animals are not affected with tuberculosis to the

same extent. Very great differences exist with regard to age. Young animals up to one year are very rarely affected with tuberculosis. With each additional year of age, however, the frequency of the disease increases, so that in old milch cows, the veterans among food animals, the greatest and most alarming dissemination of tuberculosis is observed. In the animals of Berlin butchers, who slaughtered only superannuated milch cows from ten to fifteen years or more of age, I found, on an average, 75 per cent. of the lungs of these animals tuberculous. Quite in harmony with this finding, Fischoeder in Bromberg found 56 per cent. of tuberculosis among cows in general, without regard to age. This increase in the frequency of tuberculosis with increasing age clearly indicates that in cattle the chief source of infection is to be found in cohabitation with diseased animals. In agreement with this condition, we have the prevailing form of the primary infection in cattle (primary pulmonary tuberculosis), as well as the fact that in all regions in which a frequent change in a herd of cattle occurs, tuberculosis is of much more frequent occurrence.

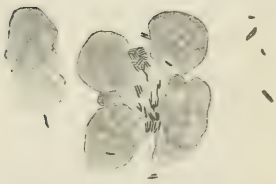
2.—Bacteriology and Pathogenesis.

The tubercle bacillus, the discovery of which by Robert Koch in 1882 must be reckoned with the greatest achievements of scientific investigation and with the most important conquests of medical knowledge, is a small, delicate, non-motile rod, five to six times as long as broad. It is from 3 to 4 μ in length. The tubercle bacillus may be cultivated on artificial nutrient media, blood serum and glycerine agar, but only at a temperature between 30° and 41° C. The optimum temperature is 37.5° C.

In the living tissue, the tubercle bacilli exercise a slow but progressively destructive action through their constant proliferation. With regard to the details of the pathogenic action of the tubercle bacilli, the excellent investigations of Baumgarten give us a deeper insight, after the nature of the tubercle bacillus has long been known pathologico-anatomically, as a result of numerous thorough and clever investigations. Inoculated tubercle bacilli at first multiply at the point of inoculation and penetrate the leucocyte wall set up in consequence of the operation. From the sixth day on, in case of inoculation into the eye, one observes the first epithelioid cells, the first typical elements of the tubercle, which arise from fixed tissue cells as a result of the specific irritation of the tubercle bacilli. With increasing multiplication of the bacilli,

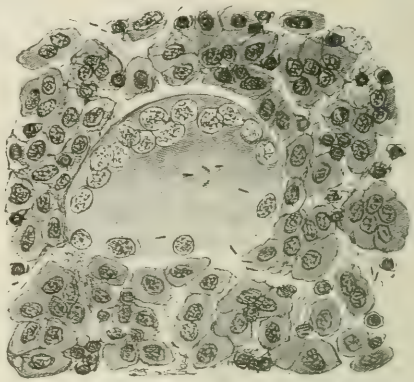
the further formation of epithelioid cells ceases. Those already formed, however, swell, become multinuclear, and, as a rule, giant cells are formed within the tubercle (Fig. 209). The formation of giant cells fails to occur only in case of extensive penetration of the tubercle bacilli or of the penetration of very virulent bacilli. In tuberculosis of cattle, however, one always finds giant cells in large numbers. Simultaneously, a sharp connective tissue delimitation of the small tubercle becomes apparent. This, in contrast to the condition in man, attains in domesticated animals a considerable thickness in certain organs.

Fig. 208.



Tubercle bacilli in smear from a bovine casefied bronchial gland. × 500 diameters.

Fig. 209.



Giant cell from tuberculous tissue, with peripheral nuclei and isolated bacilli. × 500 diam.

The tubercle thus formed is non-vascular. Its existence is, therefore, limited. It regularly becomes affected with regressive metamorphoses, caseation and calcification.* In cases of exclusive infection with tubercle bacilli, suppuration never occurs. This is always produced by a simultaneous, so-called, mixed infection with putrefactive bacteria.

Caseation in the larger tubercles becomes macroscopically visible as a result of a cloudiness in the center. Calcification is distinguished by a grating sound on making a section with a knife, and effervescence after the addition of acids. Tuberculous primary

* Among empirical meat inspectors, we unfortunately observe the lamentable error that processes are not considered as tuberculous until a pronounced caseation has taken place. It can not be too strongly urged upon empirical meat inspectors that fresh foci are much more dangerous than old, caseated and calcified ones.

infections may be rendered harmless for the organism and may heal in consequence of calcification. In other cases, however, new tubercles constantly appear in connection with the degenerated ones, so that finally extensive pathological products arise from these invisible processes.

The tinctorial behavior of the tubercle bacilli possesses special interest. They are stained with difficulty and take basic anilin stains only after long exposure, or under the influence of warm staining solutions, or with the addition of mordants (anilin oil, carbol) to the staining solutions. After the tubercle bacilli have taken the stain, however, they retain it even when treated with mineral acids. Tubercle bacilli are, therefore, characterized as acid-fast. This property is possessed by the tubercle bacilli as well as the lepra, smegma, hay, butter and manure bacilli (the group of acid-fast bacilli). This property of these bacteria is apparently due to the possession of a waxy or chitinous substance. Although this property can not be considered as a specific characteristic of the tubercle bacilli, it nevertheless makes possible the certain demonstration of tubercle bacilli in suspicious organic foci, since in such locations, with the exception of the mammary cisterns, and perhaps also caverns in the lungs, other acid-fast bacteria do not occur. The best known methods for the demonstration of the tubercle bacilli are those of Koch, Erlich and Ziehl. Ziehl's method, as modified by Gabbet (preliminary staining with carbol fuchsin and subsequent staining with sulphuric acid methylene blue) can be best recommended for practice, since it is the most speedy. Tubercle bacilli are frequently demonstrable by staining only in more recent foci. In older foci, on the other hand, especially in the horse and hog, the demonstration is frequently impossible. In such cases diagnosis can be made certain by the inoculation of guinea pigs.

Resistance of Tubercle Bacilli to Heat and Preserving Reagents.— A large number of experiments have been made with regard to the resisting power of tubercle bacilli against high temperatures. The gist of the results is that the tubercle bacillus possesses only moderately strong resistance to high temperatures. This has been determined beyond question, especially by the experiments instituted by the elder Bang, Schirl, Fischer, Völsch, Grancher and Gennes. These authors experimented in part with sputum in which in consequence of the protecting mass of mucus surrounding the bacilli, the destruction of the latter was more difficult than when they were uniformly distributed. Bang determined that a temper-

ature of 85° C. was sufficient to render the tubercle bacilli harmless. Jersin found that tubercle bacilli, when uniformly distributed, were killed by an exposure for ten minutes to 75° C., while a temperature of 65° C. did not have this effect.

Forster, in coöperation with de Man, demonstrated by careful experiments that for the destruction of the tubercle bacilli the higher the temperature the shorter the required time of exposure. In the experiments of Forster, the tubercle bacilli were killed at a temperature of 55° C. in four hours; at 60°, in one hour; at 65°, in fifteen minutes; at 70°, in ten minutes; at 80°, in five minutes; at 90°, in two minutes; at 95°, in one minute.

Tubercle bacilli appear not to form spores; at least in the investigations of Schmidt-Mülheim it was found that tubercle bacilli without exception lost their virulence at the coagulation temperature for albumen, and he states, therefore, that one is scarcely justified in considering as spores the light-colored oval structures which one observes in the body of the tubercle bacillus (Fig. 210).

Fig. 210.

Tubercle baccili with light colored deposits, strongly magnified.

Against preserving materials, the tubercle bacillus, as shown by the investigations of Forster, are very resistant. He sprinkled pure cultures of tubercle bacilli with sterilized common salt and found the bacilli still infectious after two months. Pieces of tuberculous organs, finely minced, were allowed to lie for eighteen days in salt brine and were found by inoculation to be still capable of development. Later, Forster, in coöperation with de Freitag, investigated the influence of smoking upon the virulence of tuberculous masses of meat. He salted meat which was thickly covered with pearl disease masses and hung it, *lege artis*, in the smoke. In inoculation experiments with guinea pigs and rabbits, it was found that even salting with a subsequent smoking was not sufficient to destroy the infectiousness of the tuberculous masses. On the other hand, the virulence was lost when the salted pieces of meat were smoked for three or four hours at three different times or when, after one smoking, they were preserved for at least one and one-half to two months in a dry room.

Influence of Dilution Upon the Virulence of Tubercle Bacilli.—Quite remarkable is the influence of dilution upon the virulence of tubercle bacilli, especially in view of the previously entertained notion that a single tubercle bacillus was sufficient to injure the health.

According to the experiments instituted by Gebhardt and Bollinger, the virulence of the milk of tuberculous cows, as demonstrated by intraperitoneal inoculation, was destroyed by a dilution of from 40 to 100 times. As compared with such milk, however, the sputum of consumptive patients possesses a great infective power, for this material endures a dilution of even 1 : 100,000 when inoculated subcutaneously or intraperitoneally, or when inhaled. These methods of infection, however, are to be considered as very delicate tests for tuberculous virus, for, when administered per stomachum, 2 cc. of sputum in a dilution of 1 : 8 did not give positive results.

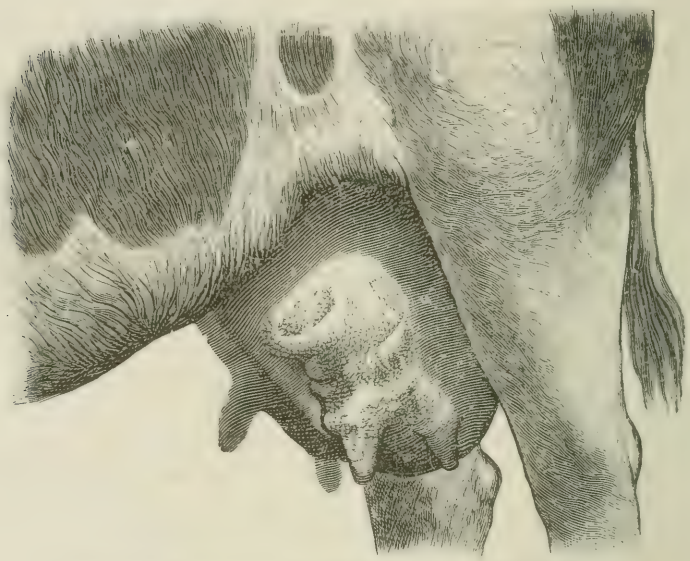
Behavior of the Tubercle Bacillus When Ingested with Food.—On the basis of artificial digestion experiments Falk first called attention to the resisting power of the tubercle bacillus to the gastric juice. Strauss and Würtz found that tubercle bacilli still retained their virulence after remaining six hours in the gastric juice and that they were not destroyed until after 24 hours' exposure. Zagavi demonstrated that tubercle bacilli exposed to artificial gastric juice at a temperature of 38° C. still retained undiminished virulence after three to four hours, caused only a local tuberculosis without a tendency to generalization after 7, 8 and 9 hours, and did not lose their virulence after an exposure of from 18 to 24 hours. Similarly, Wesener determined, by feeding tuberculous sputum, that with small quantities "nothing happens." With large quantities, on the other hand, tuberculosis of the mesenteric glands is produced, and only after repeated feeding of large quantities does tuberculosis of the intestine and also of the liver and spleen arise. In accord with these statements are the experiments of Cadéac, who undertook to determine in guinea pigs under what external conditions alimentary tuberculosis is produced. He fed tuberculous material to 56 guinea pigs, divided into four lots, which received 4, 3, 1 and 0.3 gm., respectively. It appeared from these experiments that alimentary tuberculosis was not produced with certainty, except when the guinea pigs received at least 1 gm. of tuberculous material moderately rich in bacilli. When the comparatively large amount of 0.3 gm. was fed, on the other hand, the result was uncertain, varying and limited.

3.—Clinical Symptoms of Tuberculosis.

Tuberculosis may produce various symptoms according to the extent of generalization and the preferred seat of the tuberculous

alterations. A knowledge of these symptoms is of importance for expert meat inspectors, since, especially where insurance funds are maintained, it is their duty to identify visibly-diseased animals before slaughter. The two principal forms under which tuberculosis appears clinically are tuberculous broncho-pneumonia (the formerly so-called lung plague) and tuberculosis of the serous membranes (so-called pearl disease). In the first form one observes in acute cases a frequent hollow cough which is easily induced artificially (while the healthy beef animal does not react

Fig. 211.



Mammary tuberculosis. Affection of both left quarters.

to pressure upon the larynx), and also a dry, rustling sound upon thoracic auscultation. These are the most frequent and reliable symptoms of tuberculous broncho-pneumonia. The nutritive condition is an inconstant criterion for the recognition of tuberculosis. It is only in acute cases of the disease that it is visibly disturbed. The hair is then dull and the skin is of a leathery character and crackles when raised. In such advanced cases one observes at the same time a slight dulness of the sensorium (dejected expression) and languid movements.

In a cursory inspection in stock yards, serous tuberculosis is recognizable with certainty *intra vitam* only in the most advanced

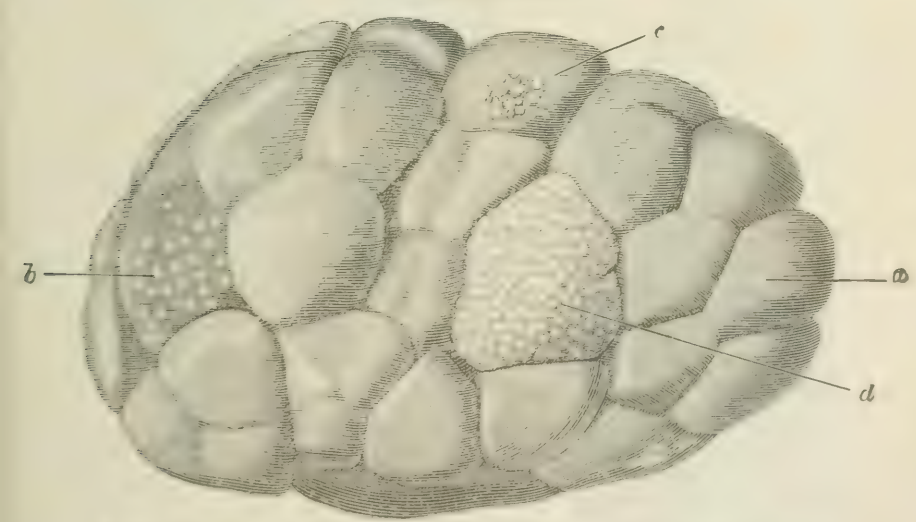
stages and then simply by the above described serious disturbances of the nutritive condition.

In special cases, however, the suspicion of tuberculosis may be changed to certainty by the presence of hard swellings in the lymphatic glands which are accessible to external examination, painless thickenings of the joints and a tuberculous affection of the udder. The latter represents an unusually characteristic affection. There are either isolated firm tubercles in the udder, or one or more quarters, rarely the whole udder, is diffusely swollen (Fig. 210), painless, at first moderately hard and finally as hard as stone. At the same time the supramammary lymph glands exhibit a considerable increase in volume and particularly a palpable deposition of firm granules and tubercles.

4.—Pathological Anatomy.

Upon post-mortem examination of tuberculous animals one finds the specific products of the tubercle bacillus in the most

Fig. 212.

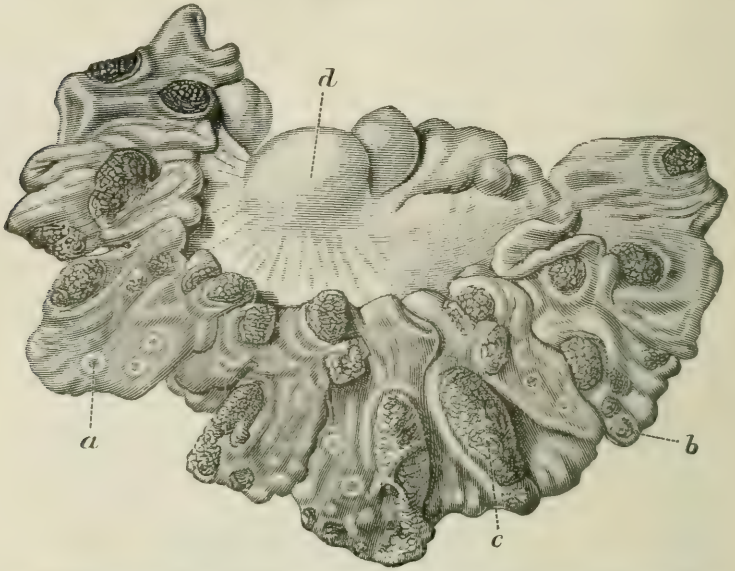


Bovine kidney with tuberculosis in different stages in the individual renculi. *a*, solitary young tubercle with incipient caseation; *b*, numerous tubercles of the same sort; *c*, older totally caseified tubercles; *d*, totally tuberculous renculus.

varying form and extent. We observe perfectly diaphanous tubercles just on the borderland of macroscopic visibility, larger tubercles with a cloudy, casefied center (Fig. 212, *a* and *b*), conglomerations

of such tubercles up to the size of a walnut or even the fist, and larger. The tubercles which lie upon the surface of the mucous membrane, after complete caseation, show a partial disintegration

Fig. 213.



Intestinal tuberculosis of cattle. *a* and *b*, lenticular ulcers; *c*, tuberculous infiltration; *d*, part of a tuberculous mesenteric gland.

which results in the formation of ulcers (Fig. 213). In some organs, as, for example, in the lungs, extensive destruction—tuberculous abscesses, cavities—may result from such ulcers in consequence of a mixed infection with purulent bacteria from the air. Otherwise, as already mentioned, these conditions are not observed in tuberculosis of the domesticated animals (rare cases of primary intestinal tuberculosis excepted, in which the formation of tuberculous abscesses in the mesenteric glands and the liver takes place in consequence of the simultaneous penetration of purulent and tubercle bacilli). For the rest, the tuberculous ulcers on mucous membranes are constantly accompanied with a purulent catarrh which may be best observed on the mucous membrane of the uterus.

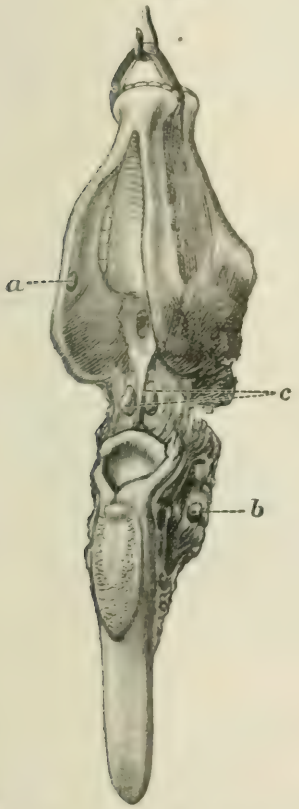
Fig. 214.

Serous tuberculosis of cattle (pearl disease).

Tubercles which do not appear upon the surface of the mucous membrane, but which lie deeper in the tissues, preserve their original form, although they may be modified in completely cloudy, yellow, caseous foci and at last may be totally calcified.

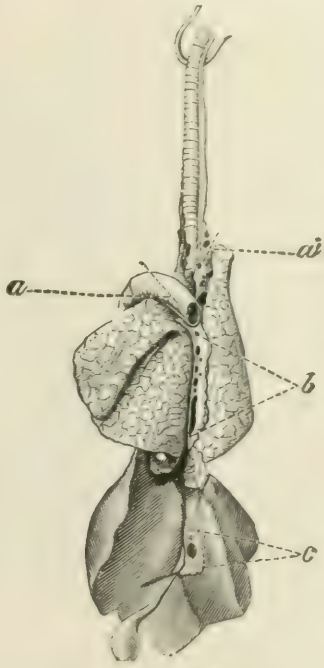
We must characterize as an anatomically-special form of tuberculosis the so-called pearl disease (serous tuberculosis) which is

Fig. 215.



Beef head. *a*, right, *b*, left submaxillary glands, *c*, retropharyngeal glands.

Fig. 216.



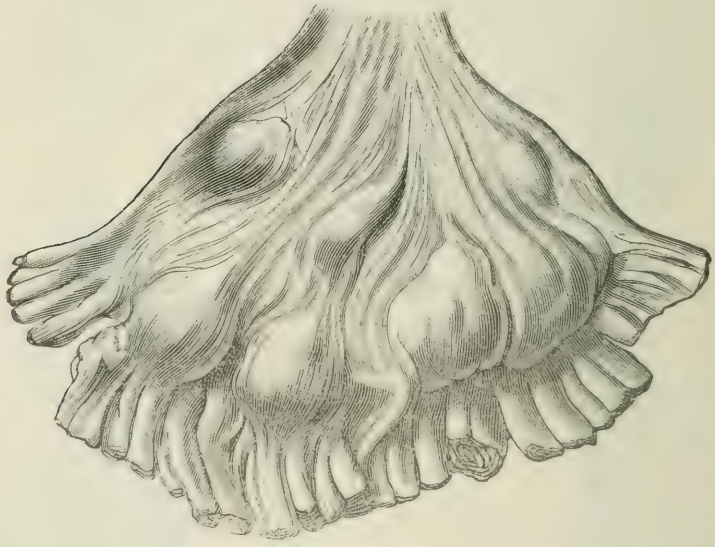
Calf "sling."
a and *a*1, bronchial glands; *b*, anterior and posterior mediastinal glands; *c*, portal glands.

very frequent in cattle, in contrast with hogs. In this form of tuberculosis one observes at first connective tissue outgrowths, rather richly supplied with blood, which grow over the parietal and visceral layers of the pleura and peritoneum in the form of a velvet-like coat. Later cloudy points appear in the connective tissue

outgrowths, and these form caseous foci which may lead to extensive thickenings or depositions upon the serous membranes. As already indicated, the tubercles on the serous membranes are distinguished by the fact that they possess a well-delimited connective tissue. Furthermore, they have a tendency to early calcification. Finally, it is worthy of consideration that serous tuberculosis, as well as tuberculosis of the lymph glands, digestive and respiratory apparatus may be apparently primary affections.

This remarkable phenomenon is to be ascribed to the fact that the tubercle bacilli, contrary to the assumption of Baumgarten and Tangl, do not regularly produce tuberculous alterations at the point

FIG. 217.



Beef mesentery with tuberculous lymphatic glands.

of entrance after obtaining entrance into the body, but, as shown by Bollinger, are able to pass through the epithelium of the mucous membrane, and a specific affection may be produced first in the neighboring lymph glands.

Primary and Secondary Foci.—The tuberculous foci found in the animal body must be classified into primary and secondary, according to their origin. For the sanitary judgment of the meat of tuberculous animals, it is desirable to give an especially clear definition of these terms.

It would seem desirable to include under primary affections, or under tuberculous foci which arise primarily, all processes which arise immediately at the point of entrance by direct infection from the outside world and in the neighborhood of this point, without the co-operation of the circulation, but simply by local growth or translocation of the bacilli by means of the lymphatic vessels. To this class belong, therefore, primary alterations of the mucous membrane, tubercles in their vicinity, affections of the corresponding lymph glands and the tuberculous foci on the serous membranes which arise by extension of the original infection.

As a rule, hogs and young cattle are affected by alimentary tuberculosis—primary affection of the digestive apparatus and the corresponding lymph glands—while, on the other hand, older cattle are as regularly affected by inhalation tuberculosis—primary affection of the lungs (tuberculous broncho-pneumonia), or of the bronchial glands.* The hematogenous embolic foci which arise through the agency of the blood circulation must be characterized as secondary processes in contrast with the primary ones. These lie in the internal organs, at points at which the arteries undergo branching into the capillaries (in the interstitial connective tissue). They do not, therefore, communicate with the outside world, and grow to become large tubercles within the tissue. The embolic foci are characterized by the fact that in the majority of cases a simple caseation and calcification, and only exceptionally suppuration, are observed. Moreover, they have a tendency to retain a round form even when they have grown to be large conglomerations.

All organs which are not in direct communication with the outside world contain merely embolic tubercles, while in other organs both the processes, viz., primary and embolic, may be observed in in co-existence. As we shall see later, the distinction between embolic and primary foci in the lungs possesses special importance; for it is necessary in rendering a sanitary judgment in individual cases to determine whether it is a case of primary tuberculosis, broncho-pneumonia, or embolic, pulmonary tuberculosis.

The anatomical picture of the most important tuberculous organic diseases has already been discussed in the section on "Organic Diseases," to which reference is here made.

* Attention may be called in this connection to the fact that for the certain recognition of slight primary foci it is necessary to make an incision into the retropharyngeal lymph glands in cattle and the laryngeal lymph glands in hogs (Fig. 215), as well as the mesenteric (Fig. 217), portal, mediastinal and bronchial glands (Fig. 216) in all animals.

5.—Diagnosis and Differential Diagnosis.

The number of pathological alterations which may be confused with tuberculosis is large, and in this connection attention will be called to them briefly, especially since they may be present in an animal simultaneously with tuberculosis and may lead to the erroneous conclusion that the distribution of the disease is much greater than it actually is.

The most important alterations from the standpoint of differential diagnosis are actinomycotic processes in the organs of the mouth cavity and in the lungs, more rarely in the bones and in the udder; echinococci and cysticerci in cases where, in consequence of a coagulation necrosis or of inflammatory alterations of the surrounding membrane, they may have become modified into a caseous or plaster-like mass in the lungs, liver, spleen, lymph glands and under the serous membranes; pentastomes in the lymph glands of cattle and sheep; strongylid tubercles in the lungs of sheep; simple purulent processes, for example, purulent catarrh of the uterus and abscesses in the lungs, liver, spleen and kidneys; leukemic infiltrations in the liver and kidneys; neomorphs, especially sarcomata in various organs and lymph glands. Finally, in cattle, calcifications in the peritoneum (page 286) are of differential diagnostic value, as well as the similar processes in the presternal connective tissue (page 354); and in hogs the peculiar alterations of hog cholera in the intestines and in the mesenteric glands.

The possibility of confusion with tuberculous processes occurs most frequently in cases of caseated echinococci, calcified pentastomes and actinomycotic foci. These alterations, however, quite aside from their peculiarities, may be easily distinguished from tuberculosis by a slight magnification on account of their characteristic features (lamellate structure of the cuticular echinococci (Fig. 163), claws in pentastomes (Fig. 168), and fungous weft and mycelia in actinomycosis (Figs. 222, 225).

For the rest, tuberculous processes possess the following special characters: (1) They are composed of minute tubercles which at first are perfectly gray and transparent, later become cloudy in the center and finally cloudy throughout; (2) the presence of minute tubercles around the larger tubercles; (3) the regular sympathetic affection of the corresponding lymph glands in a typical sequence: first, swelling, then formation of tubercles in the

glandular tissue, and, finally, caseation and calcification of these tubercles.*

Aids in the Diagnosis of Tuberculosis.—In doubtful cases one may make the diagnosis certain by demonstrating the tubercle bacilli according to the method of Ziehl-Gabbet (page 609). This method is simple and gives good results. It should not be forgotten, however, that a caseous focus may have a tuberculous origin without its being possible to demonstrate tubercle bacilli in it by bacteriological methods. Nevertheless, such foci are very virulent, as one may readily convince himself by inoculating the anterior eye chamber, peritoneal cavity, or subcutis of guinea pigs. We do not understand the cause of this negative result from the staining method. It has often been assumed that tubercle bacilli are contained in such foci in the form of spores, but, according to the above mentioned investigations of Schmidt-Mülheim, the existence of spores of tubercle bacilli is improbable. Inoculation is thus the surest means of demonstrating the tuberculous nature of a suspicious process, but even in the guinea pig, which is the most susceptible animal to tuberculosis, there is the disadvantage that the result of the inoculation can not be known until after several weeks, and thereby inoculation becomes valueless in the practice of meat inspection.

Diagnosis of Tuberculosis of Hogs.—As shown by Perroncito, tinctorially-demonstrable bacilli are quite frequently absent from caseated and calcified products in hogs. It would, however, betray a great lack of understanding of the nature of an outbreak if one should deny the existence of tuberculosis in hogs in cases where the bacilli could not be demonstrated in this manner. This position would not be justified until inoculation experiments with the suspected material had given negative results.

It has been shown by Olt that, in tuberculosis of hogs, the tubercle bacilli may be readily demonstrated in section preparations even from foci in which they were not demonstrable from smear preparations.

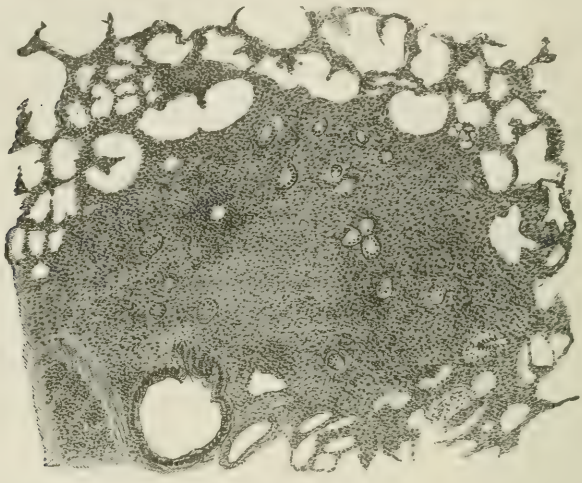
As stated on page 345, I found a simple microscopic examination of a teased preparation under a magnification of 40 diameters

* With the exception of tuberculosis, caseation occurs in the lymph glands only in consequence of hog cholera and pseudo-tuberculosis in sheep. Moreover, caseified cysticerci and echinococci may be present in the lymph glands and pentastomes inclosed in caseated and calcified masses.

to be a very convenient diagnostic aid. One may thus distinctly observe round or oblong giant cells which are especially well developed in the tubercles of domesticated animals.*

This method is well adapted to the examination of suspected lymph glands for the presence of macroscopically invisible eruptions of tubercles. While simple, non-specific lymphadenitis

FIG. 218.



Miliary tubercle with numerous giant cells, × 75 diameters.

exhibits an uniformly transparent tissue when examined in the above mentioned manner, one observes, when tubercles are present, roundish, cloudy foci with giant cells in the center and epithelioid cells around the periphery (Fig. 209). The latter are never wanting, while the giant cells may sometimes be absent.

6.—LOCAL AND GENERALIZED TUBERCULOSIS.

We commonly characterize as local diseases those which are restricted in an anatomical sense to one organ. In the case of tuberculosis, we extend the meaning of the local character, since

*Giant cells are found also around encapsulated foreign bodies and constantly in a radial arrangement around *Echinococcus multilocularis*, as well as in the neighborhood of colonies of actinomyces. These conditions, however, may be readily distinguished from tuberculosis by the above mentioned method of examination, since in the first case the foreign bodies, and in the other cases the echinococci or actinomyces, are demonstrable.

this condition is set in contrast with the dissemination of the disease throughout the whole body. The latter condition, however, is possible only through the aid of the systemic blood circulation. Tuberculous processes, therefore, are characterized as local in the broader sense as long as a mere extension or distribution has taken place through the lymphatic vessels, and the general circulation is not concerned in the dissemination of the tuberculous virus.

In cases where the systemic blood has become the carrier of the virus, we characterize this condition as generalized or general tuberculosis (Weigert). This distinction is of the greatest importance for meat inspection, since tubercle bacilli gain entrance into the musculature, "the meat of traffic," only by the aid of the circulating blood. The musculature, therefore, can be considered as infected and injurious to health only when the organisms of tuberculosis are distributed through the body by means of the blood (Johne). Tuberculosis of domesticated animals has a pronounced tendency to localization. This phenomenon may be explained most simply by the assumption of a prompt filtering action of the lymphatic glands as well as by the fact that the tuberculous products in domesticated animals are, as a rule, poor in bacilli. As asserted by Johne, however, and confirmed by the experiments of Nocard (see page 640), individual bacilli which accidentally escape the protective filtering action of the lymph glands, become inactive in the circulating blood.

The generalization of tuberculosis arises in consequence of the penetration of numerous bacilli into the systemic circulation. This may occur in veins affected with tuberculous processes or in tuberculous lymphatic glands; in the latter case, with the aid of the thoracic duct or the right tracheal duct. "Flooding" of the blood with tubercle bacilli is, according to Weigert, always to be ascribed to tuberculous affection of the wall of a blood vessel, or thoracic duct.

General tuberculosis appears in two principal forms: A slight infection of the blood leads to the formation of isolated tubercles in various organs; an extensive infection, to the eruption of innumerable tubercles in the majority of the organs. In the first case the small tubercles commonly grow to become large tubercles or caseous foci by peripheral expansion, since in such cases infection of the blood scarcely appears clinically and, therefore, in and of itself, gives no occasion for slaughter (chronic general tuberculosis). In the latter case, on the other hand, tubercles are often observed in a but slightly altered condition, since this form of generalization, as a

rule, gives cause for slaughter (acute miliary tuberculosis). If a slight infection of the systemic blood has preceded the extensive invasion of the tubercle bacilli, we have both processes simultaneously. Weigert characterizes this condition as a "transition form."

The Participation of Individual Organs in the Eruption of Tubercles in Cases of Generalized Tuberculosis.—After the entrance of tubercle bacilli into the circulating blood, tuberculous alterations do not, by any means, occur in all organs in food animals. One observes, on the contrary, that certain organs are constantly affected, others rarely, and some almost never. This peculiar behavior is partly explained by the peculiar connection of the individual organs with the blood circulation and by the rapidity of the circulation in them; in part, also by the presence of specific substances; for example, secretions which influence the development of the tubercle bacilli in different ways. For other organs we must assume a resisting power in the tissue itself, against tuberculosis. Thus, Ziegler characterizes the musculature as "almost immune" to tuberculosis. The connection with the blood circulation is of considerable importance, since this determines the quantity of the bacilli which may find their way into the organ. The lungs, for example, in cases where the blood is infected through the agency of the thoracic duct, receive blood which contains many more bacilli than all the other organs together, for all of the infected blood circulates through the lungs and thereby large quantities of bacilli may be removed from the blood by becoming lodged in the pulmonary capillaries. A similar condition may exist in the liver if infection is brought about by entrance of the bacilli into a branch of the portal vein. In fact, in this case the filtration of the blood through the hepatic circulation may restrict the pathological processes to the liver.

Sequence in the Organs Which Are Affected by General Tuberculosis.—The author has already called attention (Berliner Archiv, Vol. XIV) to the fact that in generalized tuberculosis of cattle a certain sequence of participation of various organs is to be observed. One finds uniformly an infection of the lungs and liver; then follows the spleen and kidneys, and then the prescapular and inguinal glands, udder, bones and joints.

When the posterior part of the peritoneum in female animals is affected, the uterus is also attacked, almost without exception.

It is a remarkable fact that in generalized tuberculosis of young cattle (up to four years of age), the spleen is almost always affected and the kidneys are free from tuberculous foci, while in older cattle the kidneys, together with the spleen, uniformly show tuberculous alterations.

In hogs, the lungs, liver, spleen and kidneys are similarly affected in generalized tuberculosis. Furthermore, affections of the bones in hogs, especially the vertebral column, are much more frequent than in cattle. Rieck, in 430 cases of general tuberculosis in cattle identified at the abattoir in Leipsic, 1880 to 1891, determined the following sequence in the affection of different organs: Lungs, 100 per cent.; liver, 83; alimentary canal, 73; serous membranes, 57.4; kidneys, 52.5; meat, 49.3; spleen, 18.6; udder, 16.7; bones, 8.8.

Moreover, Rieck found that 80 per cent. of the cases of tuberculosis were restricted to the lungs or bronchial glands. Several organs of one cavity of the body, usually the thoracic cavity, were affected in but 3.9 per cent.; the processes extended beyond the thoracic cavity in 1888 in 9.3 per cent. of the cases; in 1889, in 13.3; in 1890, in 11.9; and in 1891, in 19.6 per cent. of the cases. In a considerable proportion of the last-named cases, only the lungs and mesenteric glands were affected. Tuberculosis of the serous membranes was demonstrated in Leipsic in 10.8 per cent. of all tuberculous cattle (7.2 of male and 14.8 of female animals).

7.—Examination of Slaughtered Tuberculous Animals.

For determining the extent of the disease in animals found to be tuberculous, it is desirable to adopt a certain method of inspection.*

The essential features of this method of inspection consist in first subjecting to a regular examination the organs and groups of lymph glands which may be affected by general infection, and which, according to present knowledge, are most important in the determination of generalized tuberculosis. For this purpose the most important organs are the lungs, liver, spleen, kidneys, sexual organs, sternum and vertebral column; also the prescapular, axillary, popliteal, kneefold and inguinal glands.

Affections of the bones of the extremities, joints and skeletal musculature are always characterized by alterations of the last-

* With reference to the determination of primary tuberculous alterations in slaughtered animals, compare page 617.

named lymphatic glands. Affections of the meninges of the brain, the myocardium and the tongue possess only a slight significance, since they are seldom present and then only in the most pronounced cases of generalization. A quite subordinate rôle in the determination of generalized tuberculosis is played by the affections of the serous membranes. In judging the meat of tuberculous cattle, one must become accustomed to disregarding completely the affections of the pleura and peritoneum.

It should always be remembered that, as shown by Schmidt-Mülheim, peritoneal tuberculosis may pass over in a purely local manner to the pleura. Peritoneal tuberculosis, moreover, may be associated with a local process in the lungs, either with or without affection of the pleura and without generalization in cases where bronchial slime is swallowed and gives rise to an affection of the intestine, or, what is more frequent, to the mesenteric glands (auto-infection). Tuberculosis of the serous membranes, particularly of the peritoneum, comes into consideration only in case of affection of the uterus, since in this organ a local invasion of the specific process from the peritoneum to the mucous membrane is possible and frequent. The greatest extension of tuberculosis upon the peritoneum and pleura may, however, occur with the complete integrity of the parenchyma of the lungs, liver, spleen, etc.,* while, on the other hand, in the typical picture of acute miliary tuberculosis, or of chronic general tuberculosis with extensive alterations, even of the lymph glands, which lie in the skeletal musculature, the serous membranes are often only slightly or not at all affected.

A significance equally subordinate with that of the peritoneum and pleura and their lymph glands, with regard to the determination of the question whether generalized tuberculosis exists, is possessed by frequent alterations of the pericardium and epicardium, trachea and larynx, as well as the lymph glands of the head and mesenteries. The first-named alterations are usually associated with tuberculous processes in the lungs; the latter, however, may arise in consequence of swallowing tuberculous bronchial secretions (auto-infection, see above), or by the direct ingestion of the specific virus with the food. I emphasize this point for the reason that some importance in judging meat has been erroneously ascribed to the affection of the mesenteric glands.

* For this reason distinction should be made in affections of the organs of the thoracic and abdominal cavities between parenchymatous tuberculosis and tuberculosis of the serous membranes.

The organs which for the determination of generalized tuberculosis are without significance are to be examined next in order and merely for the purpose of determining what parts are to be condemned in case of the eventual release of the meat.

The examination of parts which are important for reaching a sanitary judgment on meat should not, as was formerly the general custom, proceed from organs known to be diseased, but from those which are presumably healthy. However unimportant this point may seem, it can not be impressed too strongly upon the meat inspector. Through the contamination of a liver by means of a knife which was previously used in sectioning a tuberculous focus in another organ, as, for example, the lungs, more damage can be done in case the liver is released after the determination of its intact character than under other conditions by the release of the meat of an animal suffering from general tuberculosis. For, by the above mentioned manipulation, the liver may receive a large quantity of tuberculous virus. It therefore frequently happens that the liver is eaten in an incompletely cooked condition. The musculature, on the other hand, is quite rarely the seat of tuberculous alterations and even its lymphatic glands are only in certain cases affected with generalized tuberculosis.

The practice which was formerly observed in certain localities of condemning all internal organs in all animals affected with tuberculosis, but which were released for sale, is a radical and, so far as human health is concerned, a safe one, but can not be approved from a scientific standpoint or from a consideration of the material loss to the producers. When it can be determined with certainty that the organ is free from pathological alterations, it should never under any circumstances be withheld from sale. If, however, it is contaminated with tuberculous material, this material must be removed, but the expert has thereby committed a technical error.

This technical error may be avoided if the examination of tuberculous animals begins, not with the organs which are known to be tuberculous, but with those which are presumably healthy. I purposely emphasize this point since the warning already sounded from another source (Deutscher Veterinar Kalender and Zschokke), not to contaminate healthy parts by tuberculous material, does not, in and of itself, furnish any guide for the manipulation and may, perhaps, bring it about that the above directions are followed by merely washing the contaminated knife before making an incision into an apparently healthy organ. More-

over, for reasons already given, all unnecessary cutting of tuberculous foci should be avoided. Butchers should likewise be expressly forbidden to cut into the tuberculous organs of tuberculous animals or to continue the operation of cutting up the animal with knives used for this purpose.

The examination of slaughtered tuberculous animals must proceed postero-anteriorly, and, on animals which are hung up, from above downward. We examine first of all the "meat" and the lymphatic glands which receive the lymph from it, and then the internal organs. In making the examination, the following sequence may be observed :

1. Popliteal, kneefold, inguinal, pubic or supramammary lymph glands.

2. In case of an intact peritoneum, the iliac and the other retroperitoneal lymph glands.

3. Vertebral column, ribs and sternum.

4. Prescapular and axillary glands. (For the examination of the latter, the anterior extremities must be removed. The prescapular glands, however, may be conveniently reached without removing the extremities by a simple incision in front of the shoulder joint.)

5. The udder in female animals.

6. The kidneys and renal lymphatic glands. (The latter are usually found by making an incision directly over the point where the renal artery branches off from the aorta.)

7. Spleen.

8. Liver.

9. Lungs.

10. The other internal organs, together with the corresponding lymph glands.

The characteristic symptoms of tuberculous affection of the above named parts of the body have already been described in the chapter on "Organic Diseases." In addition to the discussion found there, the following notes may be added with reference to the technique of the demonstration of tuberculous processes in individual organs.

The tuberculous affection of the udder is best demonstrated by palpation. The healthy udder, although of strikingly large size, possesses in all its parts a uniformly, moderately soft character. A tuberculous udder, on the other hand, as is well known, in case of striking enlargement of one or more quarters, shows a firm, often

stony consistency of the affected parts. One must remove all uncertainty concerning the nature of doubtful tubercular thickenings present in the udder by means of a cross section. It should be noted that Bang, in his well known work on tuberculosis of the udder, called attention to the absence of softened spots (abscesses) in tuberculosis of the udder. In general, abscesses in the udder are to be considered as non-tuberculous alterations. Any possible doubt, however, may be easily removed by an examination of the supramammary lymph glands.

The kidneys and suprarenal bodies are to be removed from the fatty capsule *in situ*, and after a superficial examination are to be cut open by several sections running toward the renal pelvis. Since, however, palpation as well as sectioning of the kidneys can not be performed in such a satisfactory manner that a reliable conclusion can be drawn upon this basis, for the absence of tuberculous foci, the aid of an examination of the lymph glands is indispensable for reaching a diagnosis of the condition of the kidneys.

The tissue of the spleen should be examined by making numerous parallel longitudinal sections. Moreover, even small tubercles in the spleen may be demonstrated by palpation.

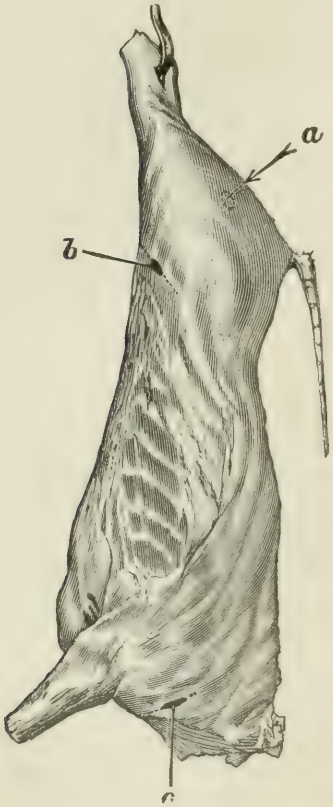
In case of the liver it must be insisted upon that the portal lymph glands shall in no case be removed before a veterinary inspection is made, for frequently these glands exhibit a much more strikingly diseased condition than the tissue of the liver.

Similar conditions are present in case of the bronchial glands and the lungs. Tuberculous alterations in the latter may be of two sorts: There are either small or large cavities (primary pulmonary tuberculosis) or round small and large tubercles (embolic pulmonary tuberculosis). The cavities have their seat especially at the base and apex, as well as in the lower border of the lungs. The embolic foci, on the other hand, are uniformly distributed in the interlobular tissue.

When inspection is made according to the foregoing directions, the inspector can, as a rule, decide without difficulty whether in a particular case tuberculosis is local or generalized. The internal organs, particularly the lungs, liver, spleen and kidneys, as well as the intermuscular lymph glands, present a more favorable nutrient medium for tubercle bacilli than the meat. The most recent alterations, incipient tubercles, are therefore much more easily and certainly demonstrated in the internal organs and lymph glands than in the various joints and in the marrow of the bones, quite aside from the fact that the dissection of the meat for the purpose

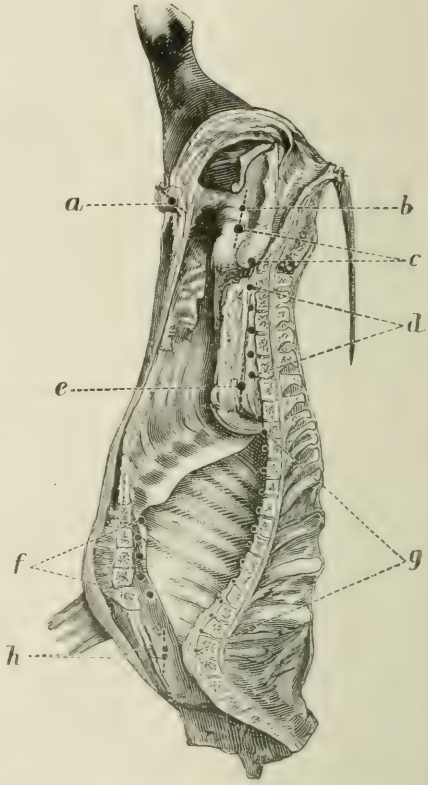
of inspection is quite limited. The alterations in the organs, therefore, together with those which may be demonstrated in the skeleton, musculature and intermuscular lymph glands, must be considered as final criteria for deciding the question whether the case is one of

Fig. 219 *a*.



Half of beef, seen from the outside. *a*, popliteal glands; *b*, kneefold glands; *c*, prescapular glands.

Fig. 219 *b*.

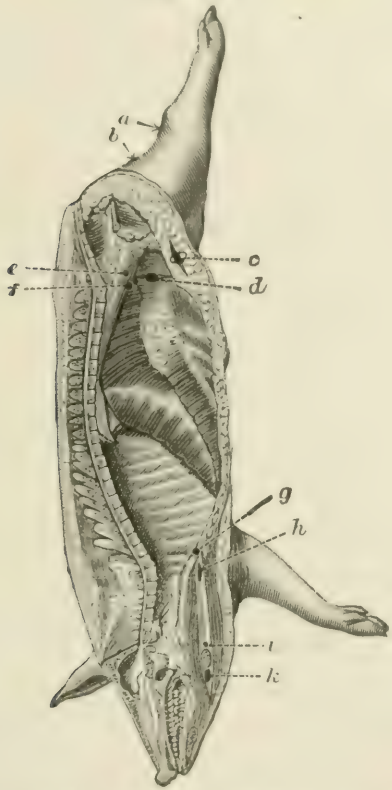


Half of beef, seen from the inside. *a*, superficial inguinal glands; *b*, deep inguinal glands (of variable size and not always present); *c*, internal iliac glands; *d*, lumbar glands; *e*, renal glands; *f*, lymphatic glands of the inferior thoracic wall; *g*, glands of the superior thoracic wall; *h*, lower cervical glands.

local or generalized tuberculosis. By means of the above described examination the organic alterations may be most perfectly determined, and, when taken together, give positive evidence on the question whether tubercle bacilli have gained entrance into the

general circulation or have distributed themselves beyond the point of entrance into the neighboring organs, or not. At the same time,

FIG. 219.



Position of the most important lymphatic glands after removal of the retroperitoneal fat tissue. *a*, lymphatic glands above the hock; *b*, popliteal glands; *c*, superficial inguinal glands; *d*, kneefold glands; *e* and *f*, internal iliac glands; *g*, lymphatic glands of the lower thoracic walls; *h*, lower cervical glands; *i*, upper cervical glands; *k*, submaxillary glands.

it may be determined by the above described method of examination what parts are to be destroyed in case the meat is released.

8.—Sanitary Judgment on Tuberculosis.

(a) Tuberculous Organs.

It must be assumed that tuberculosis may be transmitted to man by the consumption of tuberculous organs. For, tuberculosis of man and animals is produced by a bacillus which, in regard to its

form, stainability, growth, and transmissibility to small experimental animals, exhibits no essential differences. Furthermore, it is possible in a proportion of the cases, if not always, to transmit human tuberculosis to cattle, hogs and sheep. Finally, a number of cases is known in which tuberculosis of domesticated animals has been transmitted to man (skin infection from handling tuberculous material and alimentary tuberculosis after eating the milk of cows affected with tuberculosis of the udder).

By means of experiments on animals it has been shown that the tubercle bacilli introduced in food may be taken up by the lymphatic apparatus of the gums and pharyngeal cavity, and that they are also capable of passing through the stomach and may produce specific alterations in the intestines or mesenteric glands. A necessary condition, however, is that the tubercle bacilli shall be introduced in a certain quantity (see page 611).

Recently the question of the transmissibility of tuberculosis of domesticated animals to man has been thrown into doubt by Robert Koch on the basis of experiments which he carried out in coöperation with Schütz. In these experiments it was found impossible, by any method of inoculating human tuberculosis, to render cattle, nineteen in number, tuberculous, while, on the contrary, cattle which were inoculated with tuberculous material from other cattle became seriously affected and part of them died.

Before the experiments of Koch and Schütz, Pütz, Theobald Smith, Frothingham, Dinwiddie and Gaiser had demonstrated the difficulty of transmitting human tuberculosis to cattle; Koch and Schütz, however, conducted their experiments, in so far as they operated with pure cultures, exclusively with one culture. This is of the greatest significance in judging the results, as was shown by the experiments of Thomassen. He infected four cattle with four cultures of tubercle bacilli of various human origins and produced positive results in two cases. Furthermore, Karlinski succeeded in infecting cattle with human tuberculosis in ten cases during twenty-five experiments. Similarly, Bollinger, Kitt, Frothingham, Crookshank, Svennson, Délepine, Arloing, Krebbs and Rievel, as well as de Jong, obtained positive results in the transmission of human tuberculosis to calves. We may, therefore, agree with Thomassen when he states that it is difficult but not impossible to transmit human tuberculosis to cattle.

In the case of hogs and sheep, even Koch and Schütz succeeded in part of their experiments in producing tuberculosis, if only of a local character, in the experimental animals by means of

tuberculous material of human origin. In hogs and sheep also, tuberculous material of bovine origin was found to be much more infectious than that of human origin.

The rarity of primary intestinal tuberculosis in man seems to speak for the soundness of Koch's assumption. The question should not be decided by this evidence, but rather by the occurrence of primary tuberculous alterations in the laryngeal, cervical and mesenteric glands, which affections appear much more frequently after the ingestion of tubercle bacilli with the food than does a tuberculous affection of the intestinal mucous membrane. Heller in Kiel recently found that in nearly one-half of the cases of tuberculosis of children there was an affection of the mesenteric glands. Moreover, Dr. Still, working on material obtained from autopsies in a London hospital for children, found 29.1 per cent. and Dr. Shennan in Edinburgh found primary tuberculosis in 28.5 per cent. of the cases of tuberculosis in children.

Negative results in the transmission of a given race of tuberculous cultures of bovine origin to man, as reported by Baumgarten, are not sufficient, according to the results of the experiments by Thomassen and Karlinski, to prove the non-transmissibility to man of bovine tuberculosis.

In favor of the possibility of the transmissibility of bovine tuberculosis to man we have the case of Moses, that of Priester, several cases of skin tuberculosis of animal origin and cases of alimentary tuberculosis which have been observed in man after drinking tuberculous milk. The veterinarian, Moses, of a healthy family, received in the summer of 1885, a wound on the left thumb while making a post-mortem examination of a tuberculous cow. The wound healed without suppuration, although the point of the knife probably penetrated into the joint. After six months, however, a so-called skin tubercle developed on the cicatrix and the joint became loose. In the autumn of 1886 acute catarrh appeared, and thereupon a chronic hoarseness, and, in January, 1887, death resulted (Pfeiffer). Priester reported a case, observed in a surgical clinic in Kiel, of skin tuberculosis in a man who for the purpose of removing a tattooing of the skin pricked the tattoo marks and rubbed milk into the punctures. This operation was repeated several times. Skin tuberculosis developed in the punctures which were rubbed with milk on a certain day.

Concerning skin tuberculosis in veterinarians and butchers, which may be ascribed to infection with bovine tuberculosis, we have the communications of Tscherning, Ravenel, Johne, Müller in

Erfurt, Sick and the author (compare Zeit. f. Fleisch u. Milchhyg., Vol. II., No. 12). In this connection it should be remembered that skin tuberculosis can be induced artificially only with some difficulty. Chauveau did not succeed in infecting calves by superficial scarification of the skin and subsequent rubbing-in of the tuberculous material. Similarly, Bollinger obtained negative results by cutaneous inoculation of guinea pigs.

With regard to the transmissibility of tuberculosis by means of the milk of tuberculous cows, particularly such as are affected with mammary tuberculosis, the following observations may suffice: According to a report of Ollivier in the Academy of Medicine at Paris, twelve girls in a Girls' Academy contracted tuberculosis. Of this number, five died. The fact that the infected and dead girls came from healthy parents and showed principally the symptoms of intestinal tuberculosis awakened the suspicion of alimentary infection, and this suspicion was fully confirmed by the slaughter of a cow which for years had furnished the milk for the Academy.* The cow was found to be infected with extensive tuberculous processes of the internal organs and udder.†

All organs affected with tuberculosis must, therefore, be excluded from the market as dangerous food material. In this connection, it should be observed that also those organs are to be considered tuberculous in which we find merely an affection of the lymph glands, for although it is known that tubercle bacilli possess the power of penetrating intact epithelia and producing alterations in the neighboring lymph glands, nevertheless we do not know with certainty, in individual cases, that no tubercles are actually found in the organs. The organs can not be dissected to such an extent that all macroscopically-visible tubercles in them may be demonstrated. Moreover, even if this were true, the foci which stand on the borderland of macroscopic visibility might escape our attention.‡ For this reason also, as frequently mentioned, all lymphatic

* This one case, mentioned incidentally, should furnish sufficient reason for all abattoir directors allowing the milk of cows maintained at abattoirs, a very large percentage of which are found to be tuberculous, and often some with mammary tuberculosis, to be admitted to the market only after previous boiling (compare Ostertag, Zeit. f. Fleisch u. Milchhyg., Vol. V.).

† Koch has recently stated that Ollivier subsequently corrected his report and asserted that the girls did not receive the milk of the tuberculous cow.—TRANSLATOR.

‡ Rieck emphasizes the fact that in the frequently occurring affection of the bronchial glands there are often only isolated minute peribronchial foci to be found, which are distinguished from the normal parenchyma by their darker color.

glands at the natural openings (alimentary and respiratory tracts) in every food animal should be carefully examined for the presence of tubercles, by palpation and incision.

The requirement is evidently well based that even in the case of the presence of isolated foci in a given organ, the whole organ is always to be considered as dangerous to health. For, quite aside from the fact that the tubercle bacilli quite regularly make their way from isolated foci to neighboring lymphatic glands and thus pass through the apparently healthy parts of the organ, we have no means of knowing whether or not similar foci have developed at a greater or less distance from the visible tubercles. A tuberculous organ can not, like one which is infested with animal parasites, be rendered innocuous by removing the affected parts.*

On account of the danger to health from eating tuberculous organs, they should be carefully removed with all their appendices and rendered innocuous; especially the corresponding lymph glands of such an organ must in each case be excluded from market along with this organ. I emphasize this fact, since this requirement of the sanitary police is frequently violated. It sometimes happens that the lobes of the lungs are removed, but not the bronchial glands, trachea, or larynx; and also that the peritoneum or pleura is removed, but not the groups of lymphatic glands which belong to these structures. It also occurs that the mesenteric glands are condemned, but not the corresponding portion of the intestine, etc. (compare page 182, ff.).

Procedure in Cases of Local Affection of the Pleura and Peritoneum. —In local affection of the pleura and peritoneum, it is the common practice merely to remove these membranes with the lymphatic glands which lie upon them (Fig. 219). Objection may be raised to this practice that by the careless dissection of the membranes in question tuberculous material may remain on the thoracic or abdominal walls. Hartenstein, therefore, rightly demands that the removal of the tuberculous pleura and peritoneum shall be performed only by the meat inspector himself or by some other reliable official. Still better, however, is the suggestion of the same author

* A quite formidable danger lies in a procedure which I have unfortunately observed in the case of insufficiently-trained empirical meat inspectors. Such persons content themselves with the removal of the more extensively altered parts, or with cutting out superficial foci, and admit the rest of the organ to market without restriction. These improperly instructed officials do not know that they are thereby in each individual case laying themselves liable to punishment (Secs. 12 and 14 of the Food Law).

that in case of pleural tuberculosis the whole thoracic wall (ribs, intercostal muscles and pleura) be removed, and that in peritoneal tuberculosis, the whole abdominal wall, or the peritoneum, together with the lymphatic glands and abdominal muscles which lie immediately under it, should be removed.

(b) Judgment of the Meat of Tuberculous Animals.

The careful elimination of organs showing tuberculous alterations is the most important function of the sanitary police with regard to tuberculosis of food animals. Tuberculous organs constitute the chief danger to human beings. In comparison with it the danger from the consumption of the meat of tuberculous animals is slight.

The question whether and to what extent the meat of tuberculous animals possesses harmful properties has given rise to more investigations and experiments than any other problem of hygiene. The modifications of the prevailing views concerning this question during the pre-Kochian epoch may be passed over, since they possess rather a historical interest. At the present time the standpoint with regard to the mooted question may be described as follows:

The belief that the meat of tuberculous animals is, as a rule, harmless and that only in exceptional cases does it possess harmful properties must be looked upon as scientifically well founded.

It is one of Johne's great merits that he introduced clear conceptions concerning the harmfulness of the meat of tuberculous animals in the place of the previously prevailing vague and ill-defined ones. Johne established the proposition that "the gist of the question regarding the point of time from which the meat of tuberculous animals is to be considered as infected and therefore infectious is not, as maintained by Gerlach, determined by the affection of the lymph glands of the neighboring organs, but simply by the demonstration of generalized tuberculosis. This alone furnishes positive proof of the fact that the virus has entered into the systemic circulation and has infected the meat. Not until this point of time, therefore, are we justified in unconditionally excluding from the market a given piece of meat." Thus formulated, this principle constitutes a great stride in advance as contrasted with the general, meaningless phrases which formerly passed current regarding the judgment of the meat of tuberculous animals and which are, unfortunately, still to be found in some regulations concerning meat inspection.

The conception of the generalization of tuberculosis which Weigert introduced into pathological anatomy has become an axiom in meat inspection since Johne. At present, the view is generally entertained that in undoubted cases of local tuberculosis the meat is harmless, while in generalized cases it is harmful. In cases intermediate between the local and generalized forms, according to the rules which serve for the guidance of sanitary police, viz., to assume *in dubio* the less favorable condition, the meat is to be suspected of possessing harmful properties and is to be treated accordingly.

The first point, the assumption of the harmlessness of meat in cases of undoubted local tuberculosis, will probably remain for all time as an immutable dogma of meat inspection. The second proposition, on the other hand, viz., that the generalization of tuberculosis is always associated with a harmful property of meat, can no longer be maintained. Only under certain conditions and not uniformly does the generalization of tuberculosis produce a harmful property in the meat.

9.—Experiments Concerning the Virulence of the Meat of Tuberculous Animals.

Nocard made inoculations with the muscle serum of twenty-one cows which were affected with generalized tuberculosis. In only one case, however, was one of the four guinea pigs infected. Each experimental animal received 1 cc. of fresh muscle serum in the body cavity. In this connection, however, it should be remembered, as stated by Nocard, that intraperitoneal infection is by no means synonymous with the possibility of an infection through the alimentary tract. All experiments by the last-named method of inoculation gave negative results. Even the meat of the cow, the muscle serum from which produced an infection in an inoculated guinea pig, was eaten by four cats without any ill effects, although each cat received over 400 gm. Galtier, who had previously studied the question of the virulence of the meat of tuberculous animals, on the basis of later experiments (1891–1898) drew the same conclusions that he had previously drawn, namely, that the muscle serum of tuberculous animals may contain tubercle bacilli, but that, as a rule, such is not the case. In inoculating the muscle serum of fifteen tuberculous animals in quantities of from 4 to 12 cc., Galtier was able to transmit the disease to experimental animals

in only two cases. In one case, 4 cc. was inoculated into the experimental animal without any reaction, while 12 cc. produced tuberculosis.

In order to obtain information concerning the danger of eating raw meat, Galtier fed the meat of tuberculous cattle to cats, dogs, calves and hogs—as much as they would eat. In no case, however, was he able to produce tuberculosis in these animals. This result is particularly remarkable, since among the samples of meat which were fed two were found the serum from which produced pronounced cases of tuberculosis in rabbits after subcutaneous inoculation. Galtier concludes from these experiments that the consumption of the meat of tuberculous cattle is not especially dangerous, and he holds to his previously expressed opinion that in slight cases of tuberculosis the destruction of the diseased organs is sufficient, while the meat may be admitted to the market.

Van der Sluys fed ten young pigs with the raw meat of animals which were affected with acute generalized tuberculosis. For the purpose of favoring infection, bone splinters were mixed with the meat. Among the ten experimental pigs, three, or 30 per cent., became infected with alimentary tuberculosis. Forster obtained positive results in three out of seven experiments in feeding finely minced meat of highly tuberculous animals.

Bang attempted to transmit tuberculosis by means of the blood of badly affected cows. He obtained positive results, however, in only two out of 21 experiments. According to the view of this noted Danish investigator, there is no danger from eating the meat so long as tuberculosis is plainly localized. Bang states that his experiments demonstrated that the muscle serum and muscle tissue are unfavorable media for the multiplication of tubercle bacilli. Bollinger had his pupil, Hagemann, inoculate guinea pigs with the blood of six tuberculous cows. In these experiments it was found that the blood of one cow which showed extensive tuberculosis was virulent.

Under Bollinger's direction, Kastner instituted experiments concerning the infectiousness of the meat of tuberculous animals. In the first series of experiments he prepared muscle serum from 12 animals affected with tuberculosis in different degrees, and inoculated 16 guinea pigs intraperitoneally with this material. All experiments gave negative results.

This result was surprising, since Bollinger's pupil, Steinheil, had found the muscle serum of human beings, dead of phthisis, to

be uniformly infectious. Kastner's cattle, however, were affected with tuberculosis to such a slight extent that their meat could be admitted to the market. In a second series of experiments, Kastner operated with the muscle serum of cattle the meat of which, with one exception, was condemned on account of extensive tuberculosis in nearly all the organs. In the animals in question the tubercles in the lungs and other organs were casefied as in man and did not, as is usually the case in cattle, become calcified. In all, twelve experiments were instituted with the meat of seven animals. In only two cases was a negative result obtained (among them the slight case mentioned as an exception); in all the other cases, the muscle serum showed itself to be virulent in intraperitoneal inoculation of guinea pigs.

According to these recent experiments the chief attention is to be directed to the pathologico-anatomical conditions in rendering a judgment on the danger of infection. "As shown by the first series of experiments, a complete calcification of the tuberculous processes may indicate only a slight danger of infection. If, on the other hand, casefied masses are found from which the virus may escape, the danger of infection must be recognized. It is accordingly the function of meat inspection to render a judgment on this point, and that this is possible by a conscientious fulfilment of duty, is completely proved by the work of the sanitary authorities of the Munich abattoir and stockyard. For I was unable to obtain a positive result from a single case of the meat admitted to the market, while the condemned meat proved to be infectious in all cases except one" (Kastner).*

Under the term calcification, Kastner understood dry caseo-calcareous, often mortar-like metamorphoses. Under caseation, on

* That it would be quite irrational, on the basis of Kastner's highly interesting experiments, to conclude upon the necessity of a rigorous procedure of the sanitary police against tuberculosis of cattle is proved by the statistics of condemnations from meat inspection in Munich, set up as a model by Kastner. Kastner instituted his experiments in 1890 with material which had been condemned by the Munich meat inspectors. In Munich in 1890 the following numbers of animals were absolutely excluded from market on account of tuberculosis: 2 steers, 27 cows and 2 young cattle out of 23,390 steers, 21,540 cows, 7,511 bulls and 8,296 young cattle slaughtered. Among the cattle slaughtered, 394 steers, 1,352 cows, 67 bulls and 41 young cattl —a total of 1,854 animals— were tuberculous, and of this number only 41 had to be excluded from the market. This is a minimum proportion, particularly if we consider the fact that the percentage of tuberculous animals in Munich was very low; viz., 3 per cent. of all animals slaughtered, for in this 3 per cent. numerous cases of primary tuberculosis of the lymphatic glands were not included.

the other hand, which renders the meat evidently dangerous, he understood purulent caseous disintegration.*

The author instituted inoculation experiments in 18 guinea pigs with what had the microscopic appearances of being healthy pieces of muscle, lymph glands and spleen from cattle which were affected with dry caseous foci in the mesenteric glands, lungs, liver and spleen. One animal soon died of peritonitis. All other animals were found to be non-tuberculous after from 6 to 8 weeks.

Perroncito, during the years 1889–1891, conducted experiments concerning the virulence of the meat of tuberculous cattle on a large number of guinea pigs, rabbits and hogs, as well as on two cattle. These experiments, however, like those already mentioned by the same author in 1874 and 1875, had a uniformly negative result. In his experiments Perroncito used the meat of cattle which had been condemned in the abattoir at Turin on account of "a considerable extension of the disease." Part of the meat was fed, and from another part muscle serum was expressed and used in subcutaneous and intraperitoneal inoculations.

In three series of experiments with young pigs, Perroncito fed meat from tuberculous animals without producing infection in the pigs. In more than 200 rabbits and as many guinea pigs the muscle serum was injected under the skin or into the body cavity without producing a trace of tuberculosis observable when the animals were slaughtered after $1\frac{1}{2}$ months or longer. The result from subcutaneous injection of muscle serum in the two cattle was likewise negative.

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* These distinctions should be borne well in mind. Dry caseation with a strong tendency to calcification is very frequent in tuberculosis of domesticated animals. It is the usual case in alimentary tuberculosis and is, therefore, met with in a great majority of tuberculous calves and hogs. Purulent disintegration forms the exception. It takes place most frequently in primary bronchial pneumonia of cattle, sheep, old cows and steers, in which it may become very extensive under certain conditions.

The author has previously had opportunity to explain that in cattle those forms of tuberculosis are undoubtedly most dangerous, in so far as the meat is concerned, in which softened tuberculous foci are found in the organs (mixed infection of the tubercle bacilli with staphylococci and purulent streptococci). For, with the presence of extensive tuberculous abscesses at the natural entrances to the body, one usually finds embolic foci of very different age in the spleen and in the kidneys, and very frequently, moreover, an emaciation as evidence of the fact that the bacteria themselves or their metabolic products have constantly had opportunity to enter into the blood circulation. It may be incidentally mentioned in this connection that the histolytic property of pyogenic bacteria must be considered responsible for this varying condition of the dry caseous and softened tuberculous foci.

Four young pigs of Italian breed, six months old, were fed for four months on the meat of tuberculous cattle and remained healthy. Moreover, a litter of twelve pigs, two months old, were fed for five months on such meat without becoming infected.

The majority of the above described experiments were unfortunately made without an accurate determination of the extension and special condition of the process in the animals the musculature of which was used for inoculation. Data on these points would have greatly increased the value of the experiments. These experiments, however, in connection with those of Kastner, Bang and the author, justify the conclusion that the meat and muscle serum of tuberculous animals, as a rule, contain no bacilli or not enough to produce tuberculosis in the experimental animals. Only in acute stages of tuberculosis and in cases of a purulent softening of the tuberculous foci is the meat infectious. In this connection, however, it should be remembered that, even presupposing the same susceptibility to tuberculosis in man as in experimental animals, the quantity of the tubercle bacilli which produces tuberculosis in intraperitoneal inoculation is not sufficient to cause infection when administered by way of the alimentary canal (page 611). A positive result from inoculation does not, therefore, indicate an injurious property of the meat when eaten.

Accordingly, it requires no further argument to disprove the view which was once entertained in all seriousness by an expert on the occasion of a litigation concerning tuberculosis, viz., that a single tubercle bacillus is sufficient to injure human health when ingested with the food. A certain quantity of bacilli are required in order to exercise an injurious effect. For the rest, the experience of the pathological anatomists show in the most unambiguous manner that the meat of tuberculous animals plays only an inconspicuous rôle in the etiology of human tuberculosis. Baumgarten states on the basis of his experience that, despite the strong tendency of the digestive tract toward tuberculous affection, "no great significance for the origin of human tuberculosis can be ascribed" to this method of infection. "We are forced to accept this view by the fact that primary tuberculosis of the digestive tract in man is, on the whole, quite a rare occurrence." Bollinger also emphasizes the fact that alimentary tuberculosis in man is much more frequently secondary than primary. Primary tuberculosis of the intestine was observed chiefly in young individuals and was to be ascribed mainly to eating raw milk.

Moreover, when we remember that, under unregulated or badly regulated meat inspection, yearly, nay, daily, immense quantities of tuberculous organs are placed upon the market and are eaten—I would call attention merely to the frequency of pulmonary tuberculosis, to which, unfortunately, proper attention is not yet given everywhere—and that this is undoubtedly infectious material, only a very slightly dangerous property for human health can be assumed for the meat of tuberculous animals, in view of the rare occurrence of primary intestinal tuberculosis in adult human beings and the great extent of tuberculosis among cattle.*

Merely for the sake of completeness, it should be stated that the Tuberculosis Congresses in Paris in 1885 and 1891 voted for the absolute exclusion from the market of the meat of all tuberculous animals. Outside of the Tuberculosis Congresses, this, from a scientific standpoint, absolutely unwarranted requirement found no advocates. The same proposition was also brought before the Seventh International Congress for Hygiene in London and was unanimously rejected. Later Tuberculosis Congresses (1893, 1898) fortunately took a more rational view of the question, since they considered the sale of the meat of animals affected with localized tuberculosis as admissible without qualification and that of animals affected with generalized tuberculosis as admissible after previous sterilization.

Of considerable importance for the judgment of the meat of tuberculous animals is the fact, determined by Nocard, that the blood possesses properties by means of which it soon frees itself of tubercle bacilli which may be found in it. Nocard demonstrated that after the intravenous injection of tubercle bacilli the blood

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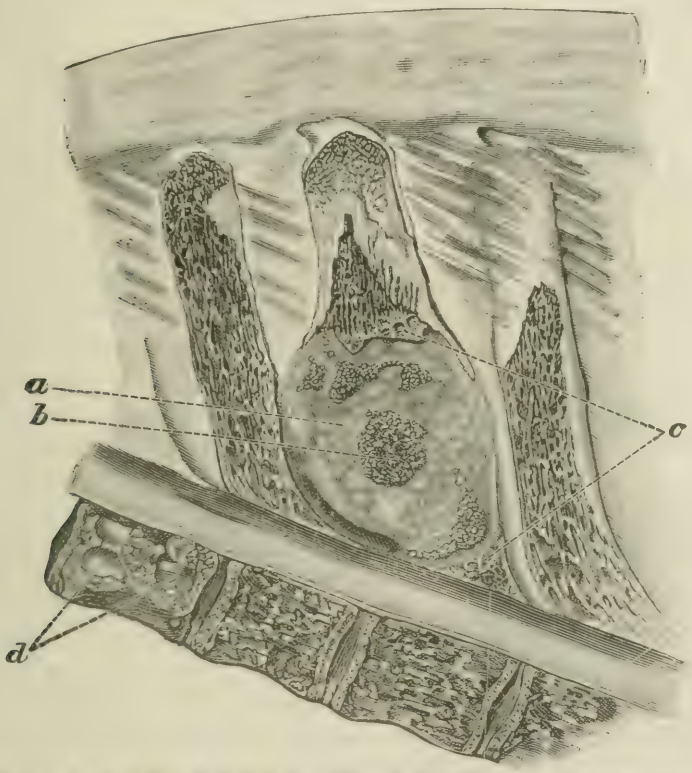
*The Bavarian Minister of State on August 11, 1879, ordered the collection of statistics concerning the distribution of tuberculosis among the Bavarian population, with especial reference to the connection between tuberculosis of man and that of cattle. During the investigation it was found, as stated by Bollinger, that a large number of isolated observations were collected which indicated the harmless character of the meat of tuberculous animals. In the village of Reiterswiesen, for example, with 452 inhabitants, almost exclusively the meat of tuberculous animals was consumed. Nevertheless, tuberculosis occurs there very rarely and the families which are the almost exclusive consumers of the meat of tuberculous animals were all found to be free from tuberculosis.

Bauwerker reports that a shoemaker lived in Alsenz who, together with his whole numerous family, had for years lived almost entirely upon the meat of tuberculous cattle. "The meat, which was often without any trace of fat, was salted, boiled and eaten." Tuberculosis was never observed in the family. Bollinger and Bauwerker called attention to the fact that in Bavaria meat is eaten only after being cooked.

loses its infectiousness within four, five, or, at most, six days (destruction and excretion of the bacilli).

It is therefore evident that the meat of tuberculous animals may be quite harmless in spite of a previous generalization of tuberculosis. The tubercle bacilli are either excreted from the body or are destroyed by a specific action of the blood. In the generalization

Fig. 220.



Tuberculosis of the dorsal vertebræ in a hog. *a*, caseous focus; *b*, deposition of lime in the caseous focus; *c*, bony bands and islands on the border of the caseous focus; *d*, section of a vertebra after removal of the tuberculous products.

of tuberculosis and the entrance of the tubercle bacilli into the blood, the musculature escapes infection for the reason that it is almost immune to tuberculosis. Even in cases of extensive flooding of the blood with bacilli, during which all the internal organs appear to be infected with tubercle bacilli, and in the so-called acute miliary tuberculosis, the musculature is usually free from tuberculous alterations.

Nevertheless, the meat of tuberculous animals, even after the process of generalization has ended, can not be unconditionally admitted to the market; for, while the musculature, "the chief constituent of the meat of traffic," is, as a rule, free from tuberculous alterations, the other elements of the meat, lymph vessels, bones and lymphatic glands in the meat, may be tuberculous. In such cases the diseased meat of tuberculous animals is to be considered, from a sanitary police standpoint, in the same category with tuberculous organs.

For the determination of such alterations in the meat, we now possess valuable criteria in the intermuscular lymphatic glands, particularly in the prescapular, axillary, popliteal, inguinal, knee-fold and iliac glands, as well as in the glands which lie underneath the spinal column. If there are tuberculous foci present in the meat, these lymphatic glands are altered. In case of localized tuberculosis, on the other hand, these glands, with the exception of the lumbar glands, which may be affected also in localized peritoneal tuberculosis, are intact. As a rule, however, it is an easy matter, from the absence or presence of embolic foci in organs which are accessible only through the blood circulation, to determine the general nature of this affection. For the rest, the less favorable condition is to be assumed. Tuberculous processes on the spinal column and sternum may be immediately recognized in animals which are cut up according to the butchers' ordinary method, since in such portions the median plane of these bones is exposed (Fig. 220). In the case of the ribs, careful attention should be given to thickenings. Alterations of the bones of the extremities manifest themselves uniformly by conspicuous alterations of the lymphatic glands in the shoulder and pelvis. Attention should also be called in this connection to the fact that costal tuberculosis is always an expression of generalization. It never arises in a local manner by extension of alterations in the pleura.

Doubt concerning the judgment of the meat of an animal in which the process of generalization has taken place (tuberculosis of the lungs, liver, spleen, or kidneys) can arise only in cases in which the tubercles in the parenchymatous tissues are very small. In such cases it may not be possible, by the ordinary macroscopic inspection, to demonstrate such small foci in the intermuscular lymphatic glands, the inspection of which is, for the above mentioned reasons, of greatest importance. It should be remembered, however, that in the lymphatic glands the tubercles grow much more rapidly and become visible sooner than in the parenchyma of

the organs. For example, in cases where the foci in the spleen are not quite the size of hemp seed, one finds in the prescapular glands, in consequence of an infection of the blood, quite conspicuous tubercles which are much larger than hemp seed. In order, however, to proceed with certainty, it is necessary in the presence of embolic tubercles in the spleen or kidneys of the size of hemp seed, not to consider the macroscopic inspection of the lymph glands lying in the musculature as sufficient, but to base final judgment upon the microscopic inspection of the lymph glands by means of teased preparations.

10.—Criteria Furnished by Experiments Concerning the Harmful or Harmless Character of the Meat of Tuberculous Animals.

According to the foregoing discussion, we must consider the meat of tuberculous animals which are infected with undoubted localized tuberculosis as harmless. To this category belong all cases of localized tuberculosis in which the tuberculous processes possess a purely caseous or calcareous character and are not purulent. We must render similar judgment concerning all healed cases of typical generalization restricted to the internal organs.

As injurious to health, on the other hand, we must characterize the meat of all cases of generalization with tuberculous alterations in the musculature, bones, joints and lymphatic glands of the muscles, and also all cases of fresh generalization with tumefaction of the spleen and all the lymphatic glands.

We must consider the meat as probably possessed of a harmful character to a high degree, and must treat it in the same manner as that which has been shown to be harmful in cases where the local character of the tuberculous process is doubtful. This is especially the case in the formation of extensive cavities in the lungs, mesenteric glands, or liver, since, in addition to the experiments of Kastner, experience teaches that in the presence of tuberculous cavities frequent outbreaks of tubercle bacilli into the blood take place, a phenomenon which is readily recognized from the fact that in such cases, in contrast with other cases, foci of varying size and, therefore, to be considered of varying age, usually occur in the spleen or kidneys.

The meat of emaciated tuberculous animals is to be judged as highly unfit for food, without regard to the tuberculous processes.

The distinction, however, between emaciation and poorness should be kept in mind.

11.—Boiling and Sterilization of the Meat of Tuberculous Animals.

At the Sixteenth Session of the German Association for Public Sanitation, Bollinger called attention to the possibility of admitting to the market in a cooked condition the meat from cases of generalized tuberculosis. At the same time Hertwig in Berlin instituted experiments to determine to what extent we are in a position to destroy with certainty the tubercle bacilli present in the meat, by boiling or some other process. The results of these experiments, which will receive special consideration in an appendix, led to the recommendation of a steam sterilizing process for rendering harmless the meat of tuberculous animals. By means of this process it is possible in a comparatively short time to heat the meat uniformly, that is, also in the central layers, to a temperature of 100° C., whereby we have the assurance that all the bacilli present in the meat will be destroyed. The organisms of tuberculosis are rendered harmless by heating to a temperature of 95° C. (compare page 610). By means of steam sterilization it is possible to save considerable quantities of the meat of tuberculous animals which formerly had to be destroyed. The meat of tuberculous animals can not immediately be utilizable as human food, even after the general introduction of the steam sterilizing process. The meat of tuberculous animals which gives evidence of a character highly unfit for food can not be improved in quality by treatment with steam, and must, therefore, be excluded from the market after such treatment, as well as before it. The same is true of meat which exhibits tuberculous foci in its substance; for tuberculous foci are not human food, even if they are sterilized.

However, all meat which heretofore had to be excluded from the market because of the local character of the tuberculosis and the harmlessness of which was consequently doubtful, may from now on be admitted to the market conditionally, after a previous sterilization.*

* Some authorities, among them the American author, Law, have raised the objection against the boiling and sterilization of the meat of tuberculous animals that the tuberculin contained in the meat was not thereby destroyed. It has been shown by A. Eber, however, that tuberculin is not demonstrable even when present in large quantities in the blood of extensively tuberculous animals.

Utilization of the Fat of Tuberculous Animals.—The Royal President of Police, in agreement with the magistrate in Berlin, has allowed the fat of rejected tuberculous hogs to be utilized as human food after previous rendering. As a result of this permission, the sides of bacon from fat tuberculous hogs, which heretofore had to be delivered to the knackers, may be removed from the carcasses, after carefully separating the tuberculous lymphatic glands or other tuberculous foci, and rendered in a digester in which a temperature of 150° C. is maintained. From a hygienic standpoint, not the slightest objection can be raised against this procedure. The sale of rendered fat, however, must take place under declaration on account of the abnormal material which is utilized in preparing the product.

12.—Obligatory Declaration for the Meat of Tuberculous Animals Admitted for Food.

In slight cases of tuberculosis, which, as a rule, are "unexpectedly met with in animals which during life exhibited a picture of perfect health," and which also exhibited no disturbance in their fattening, there is no occasion, on the basis of the foregoing discussion, to exclude the meat from unrestricted traffic. Such meat is to be considered as marketable material. In cases of extensive local distribution of the tuberculous processes, especially in cases with widely distributed serous tuberculosis, not alone upon the internal organs, but also on the membranes of the body walls, it is necessary that the meat should be sold as an inferior food material under declaration of its particular character. The meat of tuberculous animals which has been boiled or sterilized with steam is likewise to be sold under declaration.

Rumpel studied the meat of slightly tuberculous animals by means of feeding experiments with a bitch, and found, according to these experiments, that there is no reason for characterizing the meat of tuberculous animals as of inferior quality. Such meat furnished the same amount of nutriment as was secured by feeding normal meat. Likewise, with regard to the completeness of assimilation, the meat of tuberculous animals was quite equal to normal meat.

13.—Scientific Method of Procedure With the Meat of Tuberculous Animals.

1. The meat of animals with slight or not greatly extended, local, purely tuberculous alterations is to be freely admitted for

sale as marketable material after the removal of the tuberculous foci.

2. The meat of animals affected with a greatly extended, but undoubtedly local tuberculous process, is to be sold as an inferior food material under declaration (on the freibank).

3. In cases of healed generalization, restricted entirely to the internal organs (lungs, liver, spleen and kidneys), the meat is to be treated as marketable or of inferior value, according to the degree of the affection.

4. All animals, on the other hand, which exhibit pronounced emaciation, or the symptoms of a recent infection of the blood (splenic tumor and swelling of all the lymphatic glands, miliary tubercles in the lungs, liver or spleen), as well as muscle meat which is permeated with tuberculous alterations, are to be excluded from the market as unfit for human food and are to be utilized only for technical purposes.*

5. Finally, the meat of animals in which the local character of the tuberculosis and the harmlessness of the meat is doubtful (particularly in the presence of extensive tuberculous cavities and incipient disturbance of nutrition) is to be admitted to the market as conditionally marketable food material when cooked in small pieces, or, better, when sterilized with steam.

Likewise, muscle meat, after careful removal of the included lymphatic glands, bones and vascular trunks, may be utilized in cases in which merely the corresponding lymph glands, and not the musculature itself, exhibit tuberculous alterations.

With regard to the fat, it may be made utilizable by rendering in the place of cooking or steaming.

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* In animals in which only one or a few, but not all, of the lymphatic glands of the muscles are affected, the procedure recommended by Hartenstein may be unhesitatingly recommended: that only the parts which are tributary to those lymph glands should be excluded from the market; for example, in case of the affection of one kneefold gland, the corresponding hind quarter. Hartenstein recommended that the rest of the meat of such animals be admitted to the market in a cooked or sterilized condition, since "a certain suspicion" rested upon it. Since, however, we are able, by means of a careful examination, to assure ourselves whether this suspicion is well founded or not, there can be no real objection to the utilization in a raw condition of the rest of the meat which is free from tuberculous alterations (compare the Posen Declaration to the Decree of the Prussian Ministry, of March 26, 1892, page 669).

14.—Official Regulations Concerning the Method of Procedure With the Meat of Tuberculous Animals.

Under the complex conditions which prevail with regard to the sanitary judgment of the meat of tuberculous animals, the fixed form of legal provisions or of authoritative decrees does not well adapt itself to the evident requirement of the principles by which the sanitary police should be governed. In order to prevent the possibility of error, a statement of reasons must be given for the authoritative decrees and instruction for the expert inspectors. These features, however, are wanting in all official provisions concerning the procedure with the meat of tuberculous animals. These provisions, therefore, have not everywhere served their purpose as well as could be desired.

At the present time, the following legal proceedings concerning the meat of tuberculous animals are in force:*

A. *Kingdom of Prussia.*—Decree of the Ministers of the Interior, Agriculture, Education and Commerce, of March 26, 1892.

The regulations decreed September 15, 1887, concerning the judgment of the fitness for food of the meat of the tuberculous food animals, have recently given rise to an erroneous conception. We, therefore, order the repeal of this decree as well as all regulations published in technical periodicals July 22, 1882, and June 27, 1882, and of the decree of February 11, 1890, and order that the persons concerned should give heed to the following:

As a rule, a harmful character of the meat of tuberculous cattle must be assumed when the meat contains tubercles, or when the tuberculous animal is emaciated without exhibiting tubercles in its meat.†

On the other hand, the meat of tuberculous animals is to be considered fit for food (not injurious) when the animal is well nourished, and

(1) When the tubercles are found exclusively in one organ; or,

(2) When, in case two or more organs are affected, these organs lie in the same body cavity, and are directly connected with one another, or indirectly by

* Through the decrees regarding the enforcement of the Imperial Meat Inspection Law, provisions of general application have been made concerning the procedure with the meat of tuberculous animals.

† By means of a decree of the Royal Government President at Posen, July 8, 1898, March 26, 1899, issued with the consent of the Ministries concerned, the above regulation is explained as referring only to those quarters of the meat which show tuberculous alterations. On the other hand, it is held that the other quarters in which the intermuscular lymphatic glands are unaltered may be admitted to the market without restriction; and that, furthermore, the rendering and utilization of the fat of tuberculous animals as human food is to be permitted in all cases with the exception of parts infected with tuberculous alterations, which must be rendered innocuous. The sale of the fat in question may be permitted only under declaration.

means of the lymphatic vessels or blood vessels which do not belong to the systemic circulation, but to the pulmonary and portal circulation.

Since in reality a tuberculous affection of the muscles occurs very rarely, and, furthermore, since experiments conducted on a large scale for years at the Berlin Veterinary High School and at several Prussian Universities, in feeding muscle meat of tuberculous animals for the purpose of producing tuberculosis in other animals, have had for the most part negative results (The Union of the Scientific Deputation for Medical Service of December 1, 1886, Eulenburg's Vierteljahrsschrift für Gerichtliche Medizin und Oeffentliches Sanitätswesen, Vol. XLVII., pp. 307, ff.); since, therefore, the transmissibility of tuberculosis by consumption even of meat affected with tubercles is not proved, therefore the meat of well-nourished animals, even if the pathological conditions mentioned under 1 and 2 are present, can not, as a rule, be considered as of inferior value, and the sale thereof can not be placed under especial police supervision.

From the standpoint of national economy, it is desirable that meat which possesses a comparatively high nutritive value, such as that of superannuated and poor cattle, etc., shall be admitted to market, the more so since a uniform judgment of such meat in all localities is impossible when we consider the present defective meat inspection in many regions and the utter absence of meat inspection in a large part of the country.

In the future, therefore, such meat is to be freely admitted to the market. In doubtful cases the opinion of an approved veterinarian should be sought, but the courts must decide whether the meat of tuberculous animals is to be considered as spoiled and whether the sale thereof violates the provisions of Section 367[7] of the Criminal Law Statute, or the regulations of the Food Law of May 14, 1879.*

B. *Kingdom of Bavaria.*—Police regulations with regard to the inspection of cattle and sheep apparently affected with tuberculosis (pearl disease and lung plague), June 25, 1892.

Sec. 1.—If after slaughtering cattle and hogs, localized tuberculosis is found (pearl disease, lung plague) in the first stage of development, and if at the same time the slaughtered animal exhibits a good condition of nutrition, the meat of such animals, after the removal and destruction of the diseased organs, is to be freely admitted to the market and may be sold for human food.

Sec. 2. The meat of cattle and hogs affected with generalized and advanced tuberculosis (pearl disease and lung plague), and exhibiting at the same time a state of emaciation, as well as meat which contains tuberculous foci, is to be considered harmful and to be excluded from use as human food. It can not be offered for sale or sold for this purpose.

If, in case of Sec. 2, the meat inspector is not a veterinarian, a subsequent inspection by an approved veterinarian may be demanded.

Sec. 3. In doubtful cases (tuberculosis of the organs of one or more body cavities, transition forms between local and generalized tuberculosis), the opinion of an approved veterinarian is to be obtained.

If such a veterinarian finds that the conditions of Sec. 1 or 2 are not present, then the meat may be admitted to the market under certain conditions and

* A similar regulation concerning procedure with the meat of tuberculous animals has been issued in the Principality of Reuss.

restrictions and may be sold for human food, according to the degree of extension, stage and intensity of the pathological process, and according to the general nutritive condition of the animal.

C. In the *Kingdom of Saxony*, the following provisions are in force:*

1. As unfit for food are to be considered: internal organs which contain tuberculous areas, or the lymphatic glands of which are infested with tuberculous foci.

2. The meat is to be considered as unfit for food and the fat as fit for food, but not marketable (conditional utilization), in cases of tuberculosis in which the disease is generalized, that is, when the extension of the tuberculous process in the body may have taken place by means of the circulating blood (the portal circulation excepted) and when fresh (that is, not calcified, dried up, or encapsuled), or numerous older tuberculous foci are present in the muscles, bones, or the lymphatic glands belonging to them, or when acute, miliary tuberculosis is present, or when in cases of acute generalized tuberculosis, a high degree of emaciation is found.

3. The meat and fat are to be considered as unfit for food in a raw condition, but as fit for food but not marketable (conditionally utilizable) in a cooked condition in cases of tuberculosis where

(*a*) With generalized tuberculosis, the evidences of fresh generalizations are restricted to the internal organs and their lymphatic glands, particularly to the spleen, kidneys and udder, or when isolated, older (calcified, dried up or encapsuled) tubercular foci are present in the bones, muscle substance or lymphatic glands of the muscles, and these foci may be removed with certainty; or, when

(*b*) With acute and generalized tuberculosis extensive softened foci and emaciation exist.

In the same manner are to be judged and treated parts of meat which become contaminated with tuberculous material in removing tuberculous parts.

Cooking can be considered as rendering the meat harmless only when it is accomplished in a steam cooking apparatus with pieces of meat weighing not more than 5 kg.; so that the inside of the pieces of meat has been demonstrably exposed to a temperature of not less than 80° C. for a period of thirty minutes; or when pieces weighing not more than 3 kg. are cooked for not less than three hours in open kettles. The rendering of the fat can be considered as making it harmless only when this operation is carried out in kettles on the open fire or when with the use of a steam apparatus a temperature of at least 80° C. is reached before the fat is poured off.

4. All the meat, including the fat, is to be considered as non-marketable in cases where tuberculosis is acute and simultaneously generalized and where the

* In the Kingdom of Saxony, the meat of animals found to be tuberculous has been utilized as follows: In 1895, 1.93 per cent. of tuberculous cattle was destroyed, 5.51 per cent. was sold on the freibank and 92.54 per cent. freely admitted to the market; while 1.42 per cent. of the tuberculous hogs was destroyed, 24.25 per cent. sold on the freibank and 74.3 per cent. freely admitted to the market. In 1899, 1.41 per cent. of tuberculous cattle was destroyed, 5.15 per cent. sold on the freibank and 93.43 per cent. freely admitted to the market; while 0.83 per cent. of tuberculous hogs was destroyed, 26.06 per cent. sold on the freibank and 73.01 per cent. freely admitted to the market.

animals are found in a good nutritive condition, or in cases of generalized tuberculosis in which the generalization from the character of the tuberculosis is to be considered as having run its course and is restricted to the internal organs, or when only isolated, calcified, separable foci are present in the muscles, bones or lymphatic glands of the muscles.

D. The regulations of *Wurtemburg and Baden* with regard to tuberculosis are restricted to a statement that the meat in cases of "generalized lung plague or pearl disease" is to be considered as "unfit for food."

E. In the *Grand Duchy of Hessen* a decree of the Ministries of the Interior and Justice, Section for Public Hygiene, of October 12, 1883, makes the following provisions: "According to these principles the meat of tuberculous animals is to be declared unfit for food when it must be considered as infected with tuberculosis, and, therefore, as harmful, a condition which, from a scientific standpoint, occurs only "when the animal in question has been affected with generalized tuberculosis; that is, when, according to present experience, it must be assumed that the tubercle virus has entered into the general circulation and has been distributed to all parts of the body, and especially when the meat itself contains infected lymphatic glands; furthermore, when the animals, in consequence of tuberculosis or other incidental infection, are in a poor nutritive condition, or when the meat of such animals, on account of its general character, does not appear to be suiatble for human food.

"In all other cases of tuberculosis, the meat is to be recognized as fit for food but not in prime market condition. The diseased parts and the surrounding tissue are always to be removed. This must take place, especially in tuberculosis of the pleura and peritoneum, together with the parts of the meat which lie next to the pathologically-altered parts of these organs."

F. For the *Grand Duchy of Mecklenburg-Schwerin* a circular letter concerning the sanitary judgment of the meat of tuberculous animals, dated May 9, 1895, orders as follows:

According to the observations of the undersigned Minister, the meat inspectors appear to judge the fitness for food of the meat of tuberculous food animals in very different ways. Since it is of not less interest to public sanitation that meat should not be unnecessarily excluded from the market than that no injurious meat should be admitted to the market, and since the lack of uniformity in the practice of meat inspection has already produced harmful results, therefore, the undersigned Minister feels obliged to prescribe for the district veterinarians principles which, according to the present status of science, are considered by the Minister as well adapted for the classification of the meat of tuberculous food animals:

1. The following animals are to be absolutely excluded from use as food material and are to be utilized only for technical purposes:

(*a*) Those in which tuberculous alterations are found in the meat, in the bones or in the corresponding lymph glands.

(*b*) Those in which symptoms of acute miliary tuberculosis with fever are found.

(*c*) Those in which the emaciation of the body is far advanced and in which numerous widely-distributed tubercles are found, or in which the symptoms of

generalized tuberculosis are present, giving evidence of the distribution of a toxin through the systemic circulation.

2. As harmless for the consumers in a cooked condition (Rohrbeck's steam cooking apparatus), and, therefore, admissible as food material, with this restriction, is to be considered the meat of animals which are affected with tuberculosis to the extent described in 1, *c*; or the body of which is still well nourished or at least not conspicuously emaciated.

For the rest, it is not required from a sanitary standpoint and it is opposed to the interests of public economy that the meat of animals in which tuberculous alterations are found in a less extensive form than those described in 1 and 2, should be excluded from market simply on account of the presence of tuberculosis.

(Signed) THE GRAND DUCHY OF MECKLENBURG,
Ministry, Section for Medical Affairs,
Mühlenbruch.

Tuberculosis of Birds.—Through the investigations of Rivolta, Mafucci, Strauss, Gamaleia, *et al.*, it has been demonstrated that avian tuberculosis is produced by a bacillus which is not essentially different, biologically, from the organism of mammalian tuberculosis. The bacillus of avian tuberculosis resembles that of human and bovine tuberculosis with regard to form, behavior toward reagents and the gross anatomical lesions. However, as a rule, it is essentially pathogenic only for birds and not for mammals, as, vice versa, the bacillus of mammalian tuberculosis, as a rule, is not transmissible to birds. Nocard demonstrated that by repeated passages through animals the organism of mammalian tuberculosis could be rendered virulent for birds. The bacillus of avian tuberculosis vegetates at temperatures between 25° and 45° C. Mafucci emphasizes, as a prominent distinction between the pathogenic action of the two species, the fact that the tubercle of mammals usually possesses giant cells, while the latter are absent in avain tubercles.

Mafucci suggested that possibly the bacilli of tuberculosis of chickens play a part in the etiology of local tuberculosis of man.

From a histological standpoint, Pfander demonstrated that the specific products of avian tuberculosis were not completely free from, but are very poor in Langhans' giant cells (with peripheral nuclei, Fig. 209), and that they exhibit caseation, not in the form of cloudy and finely granular masses, as in the case of mammalian tuberculosis, but rather in the form of a hyaline, glassy substance.

(g) Pseudo-Tuberculosis.

Nature and Etiology.—Under the term pseudo-tuberculosis are included pathological processes which, without being caused by the tubercle bacillus, have the essential character of caseation in common with tuberculosis. The etiology of so-called pseudo-tuberculosis is exceedingly multiform. Micrococci, bacilli, cladothrices and mold fungi may cause tubercle-like processes. Formerly tubercles produced by animal parasites were classified with the pseudo-tuberculous processes; for example, when degenerated tapeworm larvæ were present in the musculature, one spoke of cestode tuberculosis. Ebstein and Nicolaier accepted this term for verminous tubercles in the kidneys of dogs and in the lungs of cats.

Occurrence.—Tubercle-like alterations which were not produced by the tubercle bacillus were observed by Eberth, Pfeiffer and other authors in guinea pigs and rabbits; by Melassez and Vignal in chickens; by Mégnin and Mosny in horses; by Hayem, Toupet and Eppinger in man; and, finally, also by a large number of observers in food animals, especially cattle and sheep. In the last named animal pseudo-tuberculosis may appear as an epizootic, as has been the case of late years in Australia and America.

Kitt described a case of bacterial caseous pneumonia in cattle. The lungs exhibited the symptoms of caseous bronchial pneumonia. The disease was distinguished, however, microscopically from tuberculous, bronchial pneumonia by the complete absence of calcification and the formation of cavities. The condition of the lymphatic glands could not be determined. In the caseous material, thick masses of fine rods were found which were 1.5 μ long and about as broad as swine erysipelas bacilli. They were readily stained by the Gram method and when so stained were to be recognized by their abundance, even in sections from the freezing microtome, under low magnification.

In connection with this, from a sanitary standpoint, highly important observation, Kitt cites the following similar cases from literature: Stöhr saw a case of pseudo-tuberculosis (caseous pneumonia) in sucking calves, which was produced by a bacillus. Nocard discovered masses of bacilli lying close together in the tubercles which occur in France in pseudo-farcy of horses and which appear in the lungs, liver, spleen and lymphatic glands and show a central caseation. These bacilli were about as long as those of swine

erysipelas and as wide as tubercle bacilli. They were stained by the Weigert modification of Gram's method. Courmont found a specific bacillus in a case of pleural tubercles in a cow, and, finally, Baumgarten found a specific micrococcus in a caseating granulation tumor in a lamb.

Preisz and Guinard reported concerning a case of pseudo-tuberculosis in a sheep. Both kidneys of a sheep which was slaughtered in an abattoir were covered with old calcified granules which greatly resembled tubercles. Koch's bacillus, however, could not be demonstrated in the granules. By the inoculation of rabbits and guinea pigs the authors uniformly obtained positive results : a rapid generalization of small tubercle-like structures which contained large quantities of very delicate fresh bacteria, rounded at both ends. This micro-organism could also be demonstrated in the tubercles of the sheep kidneys. Preisz and Guinard are of the opinion that the bacterial pseudo-tuberculoses are all identical. Later Preisz called attention to the fact that the pseudo-tuberculosis investigated by him was distinguished from true tuberculosis by the fact that, in the former, tubercles were rapidly produced and casefied immediately after their appearance, while true tubercles do not become visible and begin to calcify until three or four weeks after inoculation.

In the frequently-occurring pseudo-tuberculosis of rodents, we apparently have to do with a bacterial affection as in similar cases in sheep and cattle. The *Bacillus pseudo-tuberculosis* of A. Pfeiffer, which is identical with the zoogleacoccus of pseudo-tuberculosis, described by Eberth and others, may be successfully transmitted to house mice, hamsters, guinea pigs, rabbits and hare. The author was able to demonstrate *Bacillus pseudo-tuberculosis*, as described by Kitt, Preisz and Guinard, in caseated lymphatic glands in sheep of various origin. In one case, reported by Turski, there was an extensive outbreak of pseudo-tuberculosis in a herd of Merino sheep. Among 156 ewes, 44, or 29.3 per cent., were more or less affected. The sheep which were affected with pseudo-tuberculosis were emaciated and after slaughter exhibited caseous alterations in various lymphatic glands, bronchial, mediastinal, portal, prescapular, kneefold and other intermuscular lymphatic glands. The lymphatic glands were either completely modified into caseous foci, or were sprinkled with caseous areas, varying in size from a hemp seed to that of a hazel nut. The substance of these areas was greenish-yellow, caseous, purulent, crumbling or dry, and in layers like an onion. Calcification was completely wanting in the case

described by Kitt. Moreover, the parenchyma of the internal organs was unaltered. On the other hand, metastatic, caseous foci were found in the musculature. In these foci numerous rods, resembling those of swine erysipelas, were demonstrated by Gram's staining method (Fig. 221). These rods grew on blood serum in the form of milk-white colonies, produced pseudo-tuberculosis in mice, rabbits and guinea pigs, and killed sheep with symptoms of violent septicemia, even when inoculated in comparatively small doses. Likewise in pseudo-tuberculosis of sheep, which has occurred in epizootic form in Australia and America, the bacillus pseudo-tuberculosis in question was demonstrated as the pathogenic organism (Cherry and Bull, Nörgaard and Mohler).

Fig. 221.

Bacilli of pseudo-tuberculosis in a smear preparation of pseudo-tuberculous mediastinal gland of a sheep. × 500 diam.

Diagnosis and Differential Diagnosis.—The general symptom of pseudo-tuberculous processes, caseation, has already been mentioned. Pseudo-tuberculosis has this symptom in common with true tuberculosis. For the differentiation of the two processes, the casualistic material furnishes essentially two criteria: First, the pseudo-tuberculous tubercles appear, as a rule, not to contain giant cells or epithelioid cells; furthermore, it is to be concluded from observations thus far made that the caseous foci which appear in the lymph glands in pseudo-tuberculosis do not calcify, but dry up, and, consequently, exhibit an onion-like stratification.

Judgment.—The sanitary police judgment of pseudo-tuberculous alterations varies like their etiology. In all cases, however, the character of the process justifies the complete exclusion from the market of organs which are affected with the alterations in question, and of the meat which is sympathetically affected by the generalization process.

(h) Actinomycosis.

Etiology.—Actinomycosis (ray fungus disease) belongs to the chronic infectious diseases. It is produced by actinomyces (ray fungus), which was observed by Perroncito, Rivolta and Hahn, but

was first recognized as an etiological factor and described by Bollinger in 1877.

Morphology.—Actinomyces is classified with the pleomorphic bacteria for the reason that in cultures it forms short and long rods, simple and branched threads, spirally twisted organisms and cocci-like elements (Wolff and Israel). In animal tissues the ray fungus is observed in the form of graceful rosettes, the chief character of which consists in club-shaped swellings of the radially-arranged mycelia (Fig. 222).

In domesticated animals, actinomyces does not produce suppuration, but simply an extensive infiltration of round cells and, in

Fig. 222.

Actinomyces mycelia from a sub-maxillary actinomycoma of a beef animal. × 240 diameters.

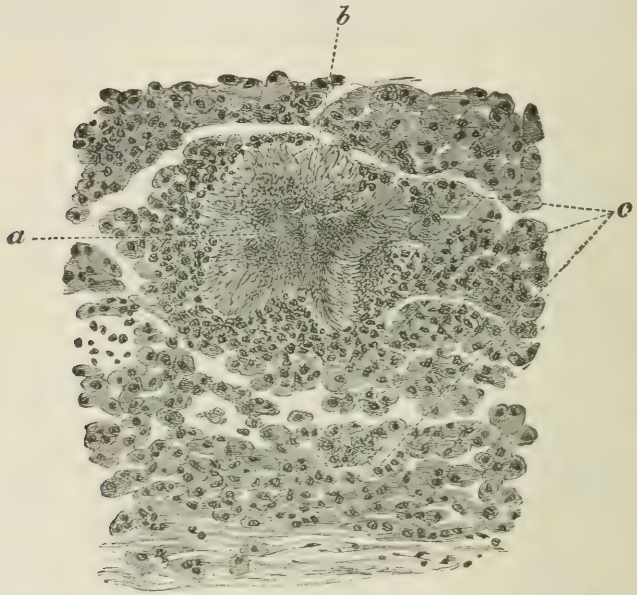
the neighboring tissue, giant cells, the formation of which, to the best of the author's knowledge, was first described by Kitt (Fig. 223). The giant cells, however, are not of such regular form as in tuberculosis, but are of a more irregular shape. Suppuration in domesticated animals is to be attributed to a mixed infection with pyogenic bacteria. In purulent actinomycotic foci, I was impressed with the fact that the fungus rosettes do not show the fine growth and development which we are accustomed to see in domesticated animals, but that they resemble in this respect more nearly the ordinary picture of actinomyces in man (Fig. 225).

By transmitted light the actinomyces rosettes exhibit an evident greenish sheen; in consequence of calcification they lose this sheen and become black under transmitted light. The ray fungus rosettes are commonly located close together, in "mulberry-like

masses," and thereby form pale-yellow granules of the size of millet seed, visible to the naked eye, and which are plainly distinguished from the diseased tissue (Fig. 224).

Pathogenesis.—Actinomyces may produce ulcers of considerable size. According to their exterior condition, these ulcers are classified into soft and firm actinomycomata, the former being the more frequent. They possess the firmness of myxofibromata, while in the case of the firm actinomycomata, the consistency is similar

Fig. 223.



Section through an actinomycotic tongue. *a*, central part of the actinomyces; *b*, radially arranged clavate hyphæ; *c*, giant cells in the adjoining zone of infiltration. × 240 diameters.

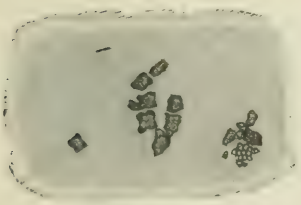
to that of pure fibromata. The firm actinomycomata are comparatively poor in mycelia. All actinomycotic foci are delimited from the surrounding tissue by a thick wall of connective tissue.

In case of actinomycosis of one part of the body, the corresponding groups of lymphatic glands may take part in the affection. Ray fungi which accidentally find their way into the afferent lymphatic vessel produce in the lymphatic glands, as well as in the other tissues, small infiltration foci, inside of which the fungus colonies may be plainly recognized (compare Fig. 223). Neither suppuration nor caseation appears in actinomycotic lymph glands.

Occurrence.—Actinomycosis is of frequent occurrence in cattle and hogs. As a rule, the disease appears sporadically. It may, however, attain an enzootic distribution (Jensen, Stienon, Claus, Neuwirth). In rare cases the ray fungus disease has been observed in horses, sheep and deer.

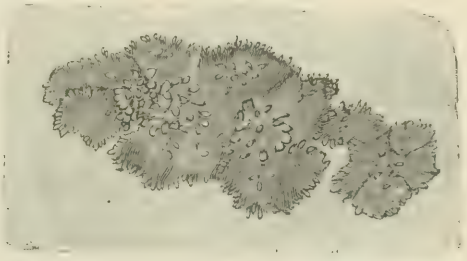
In cattle, it is especially the head which is the seat of the disease. Almost all parts of the head may be attacked by the ray fungus. Formerly the lower jaw was considered the most frequent point of attack. In this location the fungus may produce enormous deformities in consequence of rarefactive ostitis, on the one hand, and enormous granulation formations, on the other. Likewise, in the upper jaw, actinomycomata have frequently been demonstrated. According to recent investigations, however, the

Fig. 224.



Actinomyces mycelia from a laryngeal actinomycoma. × 35 diameters.

Fig. 225.



Actinomyces mycelia from a purulent actinomycoma in a beef lung. × 240 diameters.

accuracy of which the author can fully verify, the tongue must be considered as the most frequent seat of actinomycosis. Henschel and Falk called attention to the fact that besides the form of lingual actinomycosis in cattle, known under the name of wooden tongue, actinomycosis occurs in this organ quite frequently in the form of tubercles. Henschel and Falk specified a particular part of the dorsal surface of the tongue which is frequently affected with primary actinomycosis, and which must, therefore, be carefully inspected in every slaughtered animal (Fig. 52). Besides in the musculature of the tongue, one observes fungoid actinomycomata (Fig. 226, *b*) and superficial actinomycotic erosions (Fig. 226, *a*) on the mucous membrane of the tongue and also on the mucous membrane of the cheeks and gums. These erosions are distinguished from similar alterations by their firm, leathery basis. Moreover, actinomycotic foci may be plainly recognized in the form of yellow spots.

It was shown by Klepzow that in cattle slaughtered at the Moscow abattoir the mucosa and submucosa of the under lip are very frequently permeated with actinomycomata. From March to June, 1892, among 42,230 slaughtered cattle, 1.030 cases of actinomycosis were found, and among these not less than 621 cases of labial actinomycosis.

In the pharyngeal cavity, larynx and esophagus, pedunculate actinomycomata of the size of a hazel nut or a potato frequently occur (Fig. 227). These are distinguished from non-actinomycotic polyps by their rough, pale-red surface and the sprinkling of yellow spots.

Moreover, the skin of the head and neck, as well as the subcutis of these parts of the body, are frequently the seat of hard or

Fig. 226.

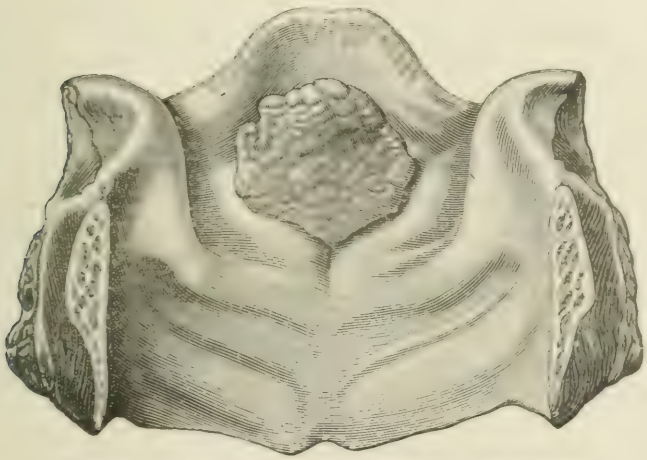
Beef tongue with (*a*) actinomycotic erosions; *b*, mushroom-shaped actinomycomata. The tip of the tongue also exhibits the condition of wooden tongue.

soft, sharply delimited or diffuse ulcers, in which, when carefully examined, yellow spots or actinomyces colonies may be observed. The neighborhood of the angle of the jaw and the larynx are very often affected with actinomycosis. According to Rasmussen, subcutaneous actinomycomata also occur on the back, elbow and femur, and in the form of the so-called knee-sponge. Lüpke observed a case of elephantiasis which was caused by actinomycosis. Actinomycosis may also take its origin from castration wounds.

Contrasted with the frequency of actinomycosis in the head, that of other organs is rare. In the first stomachs one finds pedunculate actinomycomata like those in the pharyngeal cavity and esophagus. In the lungs smaller scattered tubercles and large ulcers occur up to the size of a child's head; the latter in delimited

portions of the lungs. The large ulcers are, without exception, of a soft, myxoma-like consistency. They frequently show a central puriform softening. Hepatic actinomycosis appears either in the form of solitary ulcers (infection through fungi-bearing bodies from one of the first stomachs) or in the form of numerous abscess-like tubercles (infection through the portal vein). Actinomycosis of the udder is found in cattle in the form of tubercles varying in size from that of a pin to that of a hen's egg, and possessing a fibrous peripheral zone with a soft center permeated with actinomyces foci, or in the form of diffuse, acute inflammation with a tendency to induration. Bang and Jensen also found

FIG. 227.



Bovine larynx with an actinomycoma on the epiglottis.

actinomycomata in the kidneys. Affections of the intestines, bladder, vagina, spleen, peritoneum, vertebral column and sternum are rare. In hogs, Johne has shown that the tonsils are a frequent seat of actinomyces. Moreover, in the hog the ray fungus frequently leads to the infection of the mammary glands, which affection frequently appears in the form of a cold abscess. In the contents of the abscess one finds well developed rosettes in great quantity, which do not differ in any respect from *Actinomyces bovis*. Besides the abscess form, actinomyces of the mammary gland may appear also in the form of tubercles and large ulcers leading to suppuration and the formation of fistulæ. Fungoid actinomycomata may grow out through the openings of the fistulæ. Rasmussen states that at the abattoir in Copenhagen he observed actino-

myces of the mammary gland in hogs in 52 cases inside of three months. The same author demonstrated actinomycomata in the subcutis on the neck, in the fore-arm, abdominal wall (castration cicatrices) and hind quarters of hogs.

Finally, in the horse several cases of actinomycosis of the tongue, lymphatic glands and of the generalized form have been observed. In the sheep, one case of pulmonary actinomycosis was observed by Grips, and two cases of lingual as well as one case of labial actinomycosis by Berg. In the last named case and in one of the cases of lingual actinomycosis, specific alterations in the cavity of the lower jaw were present simultaneously.

Generalization of Actinomycosis.—The ray fungus may, under certain circumstances, exhibit a general distribution. This, however, is an extremely rare occurrence. Hertwig described a case of this sort in the hog, the only one in several million hogs which were slaughtered in Berlin. In the case in question, in addition to actinomycomata in the mammary gland, softened actinomycotic foci were found in various dorsal vertebræ. Moreover, two cases of generalized actinomycosis were demonstrated in cattle in Berlin. In these two animals, in connection with actinomycosis of the head, embolic foci had developed in the lungs, liver, and, in one case, also in the neighborhood of the kidneys. Furthermore, in the second cervical vertebra, embolic actinomycosis (granulations and granular pus) was observed in a beef animal by a Swedish veterinarian (Jensen).

Differential Diagnosis.—Upon superficial examination, actinomycosis may be confused with tuberculosis and also with simple non-specific tumors (fibromata, myxomata, etc.). In all these cases microscopic examination makes certain the diagnosis of actinomycosis. Moreover, the above described microscopic peculiarities of actinomycomata, especially the sprinkling of punctate yellow foci and the usual negative findings in the corresponding lymphatic glands, furnish important criteria for the identification of the disease, without the assistance of the microscope.

Judgment.—The question whether actinomycosis of animals may be transmitted to man has recently been made a subject of lively investigation, especially in America. The possibility of such a transmission must be theoretically admitted, since Wolff and Israel succeeded in inoculating actinomycosis from one animal to another.

However, all experience is opposed to the spontaneous occurrence of a direct transmission of the disease from animals to man.

According to statistics collected by Moosbrugger, including 75 cases, 54 in men and 21 in women and children, the greater proportion of the actinomycotic patients had no contact with animals. In 11 cases the occupation was not stated; 20 cases developed among farmers; 33 patients, however, had nothing to do with animals (millers, glaziers, tailors, merchants and students). Contact with diseased animals could be demonstrated in only one case. Of the 21 women and children, not more than 4 belonged to the farming class and none of these individuals had come in contact with a diseased animal. Concerning the transmission of actinomycosis by the consumption of actinomycotic organs or meat of actinomycotic animals, nothing whatever is known. Ponfick, Boström, Nocard, Crookshank, *et al.*, are of the opinion that man and animals become affected with actinomycosis from one and the same source, and that in this regard grains are highly suspicious. Of special importance is the communication of Boström, according to which, after he had especially directed attention to this point, he could uniformly demonstrate the undoubted presence of grains in the actinomycotic foci. Boström thereby substantiated the early observations of others, especially the observation of Lanow, Schartau, Soltmann, Fischer and Bertha, who likewise found portions of grains in actinomycotic foci in man. Since Boström has called attention to this point, the grains of barley and the chaff of oats have been found in actinomycotic foci in man by Hummel, Bernstorff and Jurnika.

These experiences agree entirely with those had in connection with domesticated animals. The usual occurrence of the disease in the anterior portions of the digestive apparatus in cattle speaks in favor of infection through the food, and the affection of the mammary glands in hogs, of infection through straw. Furthermore, one quite frequently finds positive proof of the assumed method of infection in parts of grains surrounded by ray fungi, especially cereal grains and particles of straw, within actinomycotic foci in cattle and hogs. Henschel and Falk have shown beyond question that lingual actinomycosis arises exclusively in consequence of the penetration of fungus-bearing food material. Finally, the transmission of the disease from one animal to associated animals has never been observed with certainty.

Accordingly, the assumption that the consumption of actinomycotic organs is injurious to health, is scarcely justified. Under

all conditions, we must combat this assumption for the meat of actinomycotic animals in case of local actinomycosis. The activity of the sanitary police should therefore be restricted to the removal of all affected organs, and these should be excluded from the market as highly unfit for food in so far as the removal of the specifically altered parts is not possible. This is the case in isolated foci in the tongue, and the removal of the diseased parts for the purpose of releasing the rest of the tongue is very desirable, since the tongue is so valuable an organ.

In the extremely rare cases of generalization, the whole animal should be excluded from the market, since generalization in actinomycosis appears to run a very atypic course, and the detection of all the foci (in the bones and inside the muscles) is much more difficult than in tuberculosis, in which a uniform affection of the regional lymphatic glands furnishes a valuable guide in finding the diseased parts.

(i) Botryomycosis.

History.—Under the term botryomycosis, we understand a chronic proliferation of the connective tissue which is produced by a specific micro-organism (botryomyces of Bollinger). Bollinger first found this fungus in 1869 in firm pulmonary tubercles of the size of a hazel nut or a walnut in a horse, and gave it the name "*Zooglœa pulmonis equi.*" Later this fungus, after it had been forgotten, was discovered "anew" by Rivolta, who named it "*Discomyces equi,*" as well as by Johne and Rabe, who proposed the names *Micrococcus ascoformans* and *M. botryogenus.* Hereupon Bollinger changed his first name to *botryomyces* (grape fungus).

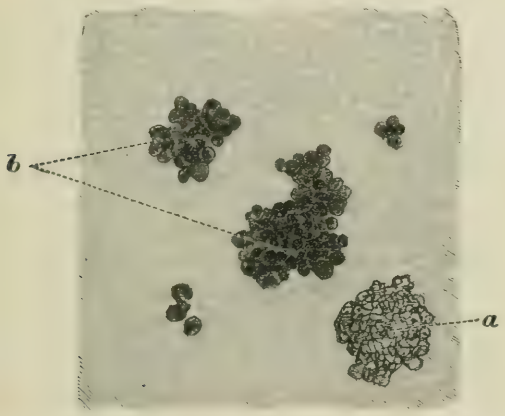
Pathological Anatomy and Bacteriology. — Through the investigations of Rabe, Johne and Kitt, concerning botryomycomata and botryomyces, the following points have been determined :

Botryomycoma is a connective tissue tumor of chronic character and peculiar structure. It has thus far been demonstrated only in horses and in one beef animal and one hog. In horses the tumor is found most frequently on the spermatic cord after castration; also in the intermuscular and intramuscular tissue in the retroperitoneal tissue, in the subcutis under the collar, on the breast and tail, and, finally, in the udder, lungs, ribs and pleura.

Botryomycosis of the lungs may arise primarily or secondarily. Kitt reported a case in which metastatic foci in the lungs developed

after a case of botryomycosis of the spermatic cord. Jensen enlarged the casuistics of metastatic pulmonary botryomycosis by three other cases: one of his own and two of Steiner and Thomsen. The case observed by Jensen is remarkable in that the lymphatic glands lying at the entrance to the thorax showed some botryomyces foci as large as nuts. A similar case was observed by Fröhner in a horse. In this case, in addition to botryomycosis of the spermatic cord, skin, abdominal musculature and lymphatic glands, metastases were present in the lungs; also botryomycotic peritonitis. Botryomycoma appears in the form of tubercles of various size which consist of a firm connective tissue framework and soft, yellowish-brown tissue in the interstices. The latter con-

Fig. 228.



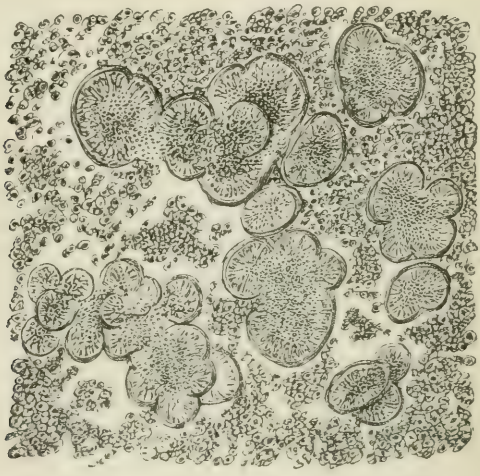
Botryomyces colonies. *a* intact, *b* calcified. × 35 diameters.

sists of small tubercles, softened in the center, in which without exception yellowish-white granules of the size of a grain of sand may be demonstrated (Fig. 228). "These depositions, of the size of grains of sand, like the similar granules in actinomycomata, are to be considered as the pathogenic criteria of this new infectious tumor" (Johne).

In a microscopic examination one observes that these depositions are nothing but "mulberry and grape-shaped conglomerations of micrococcal masses, which lie close together, are mostly round, and are about 5 to 10 or even 100 μ in diameter" (Fig. 229). These structures are held together by a membrane or capsule. The masses of micrococci are stained by gentian violet and Löffler's methylene-blue solution.

Relationship of Botryomyces to Staphylococcus pyogenes aureus.—Rabe determined that pure cultures of botryomyces killed guinea pigs, and in sheep and goats produced a round inflammatory edema. Kitt succeeded in cultivating cocci from colonies of botryomyces which possessed great similarity to *Staphylococcus pyogenes aureus* and produced suppuration as well as connective tissue proliferation. Hell states that he always obtained *S. pyogenes aureus* in pure cultures from botryomycomata. According to Poucet, Dor and Parascandolo, botryomyces is a specific bacterium, never agrees in form, size, stainability, formation of pigment and growth

Fig. 229.



Botryomyces colonies from a botryomycoma of the spermatic cord. × 240 diameters.

on various nutrient media with *S. pyogenes aureus*, and can be distinguished from it by serum diagnosis.

Differential Diagnosis.—Botryomycomata may be confused with actinomycomata, simple tumors and glanderous neomorphs. In all cases the findings of sand-like depositions and a microscopic examination make certain a positive diagnosis.

Judgment.—Botryomycosis has never been demonstrated in man. It is not impossible, however, that botryomyces may be pathogenic for man in another form than in the horse—perhaps as a purulent organism (compare the investigations of Rabe, Kitt and

Hell). For these reasons, at least, the parts of the organs which are affected with botryomycomata must be carefully removed and rendered innocuous.

3.—Infectious Diseases Which Occur Only in Animals and are not Communicable to Man in any Form.*

(a) Rinderpest.

Rinderpest possesses interest merely from a veterinary police standpoint. For clinical and pathologico-anatomical details, reference is here made to text books on epizootic diseases and special pathology. The only matter of importance to experts in meat inspection is the differential diagnosis of this plague, which, despite its unusually great infectiousness, is still quite unexplained from an etiological standpoint. As a result of the great development of our commerce, it may occur and has occurred, in spite of our strict quarantine regulations, that rinderpest has suddenly broken out in the interior of the country. This plague is, therefore, to be kept constantly in mind, in stock yards and abattoirs.

The following are the chief diseases which may give occasion to confusion with rinderpest:

Malignant catarrhal fever and *intoxications.*

In malignant catarrhal fever, as well as in rinderpest, all the mucous membranes may be inflamed (catarrhal, croupous and diphtheritic inflammations). Malignant catarrhal fever, however, is distinguished from rinderpest by its very slight infectiousness and especially by the usual involvement of the mucous membrane of the respiratory apparatus, by the appearance of parenchymatous keratitis and by the integrity of the parenchyma of the internal organs. In cases of rinderpest, cloudiness of the eyes is wanting, while, on the other hand, the parenchyma is greatly altered (cloudy swelling, fatty metamorphosis).

* The infectious diseases peculiar to the horse, viz., horse distemper, pneumonia and contagious coryza, possess only a very subordinate significance for meat inspection. This is evident, on the one hand, from the usual benign course of these diseases, and, on the other, from the low slaughter value of horses. In severe cases the owner will, as a rule, prefer the risk of eventual death to a saving of an inconsiderable slaughter value. Transmission of horse distemper, pneumonia and contagious coryza to man from eating meat, has thus far never been observed; nor have infections appeared in the attendants of animals affected with these diseases.

Intoxications are clinically sufficiently differentiated from rinderpest by the absence of infectiousness. Intoxication may, however, occur in the form of an extensive outbreak. Thus, for example, it may occur, in the careless use of gray mercurial salve as an insecticide, that several or all the cattle of a herd become sick at the same time. Mercurial poisoning is characterized by the fact that it produces alterations in the digestive and respiratory apparatus, which, to some extent, resemble the alterations in rinderpest, especially the punctate and spotted reddened areas, ulcers and submucous infiltrates in the intestines and, finally, croupous deposits on the respiratory mucous membranes. In cases of mercurialism, on the other hand, there is wanting that universal croupous diphtheritic inflammation of the mucous membranes which characterizes rinderpest.

In addition to mercurial poisoning, other intoxications may be confused with rinderpest. Such a confusion occurred a few years ago in the Rhine Province, where a large number of cattle suddenly became seriously affected after feeding on poisoned maize slump. In a subsequent investigation of the case one was inclined to ascribe the disease to the development of hydrogen arsenide which may have gotten into the slump by the utilization of impure sulphuric acid.

Judgment.— The meat of cattle affected with rinderpest is harmless for man. This is to be considered as demonstrated by the numerous experiences, especially those which were had in field campaigns. Gerlach emphasizes the fact that rinderpest followed the armies in all of the European wars of the nineteenth century and that the meat of affected cattle was eaten without any harm. From 1813 to 1815, the allied as well as the French troops received cattle affected with rinderpest, and among them many animals in an acute stage of the disease. An isolated observation of Zückert on the alleged injuriousness of the meat of a beef animal affected with rinderpest has no weight against this experimental material, especially since in the case in question it is very probable that the meat had already begun to decompose.

Despite its harmlessness, however, the meat of cattle affected with rinderpest in well regulated conditions in time of peace can not be admitted to the market, for veterinary police reasons. The Imperial law of April 7, 1869, concerning regulations against rinderpest prescribed incineration of animals killed on account of rinderpest or dead of this disease.

(b) Malignant Catarrhal Fever of Cattle.

Nature and Occurrence.—Malignant catarrhal fever is a specific disease of cattle. In all probability it depends upon the entrance of micro-organisms. Thus far, however, they have not been demonstrated. The disease is usually not directly infectious. It appears, rather, to be contracted exclusively through intermediate carriers (food, floors of stalls).

Malignant catarrhal fever in the majority of cases appears sporadically. Under certain conditions, however, it may obtain great distribation as a local plague. Frank, in Alsenz, called attention to the occurrence of catarrhal fever in an enzootic form. Many similar occurrences, however, had been reported previously. The author, himself, observed an outbreak of the disease in which, among a herd of 80 animals, 60 became more or less seriously affected within a short time.

Anatomical Findings.—Pathological alterations are primarily observed on the mucous membrane of the respiratory apparatus. The mucous membrane from the nostrils to the small bronchi may exhibit all degrees of inflammation, catarrh, croup and diphtheria. The inflammatory phenomena of the alimentary tract may be associated with symptoms in the form of a croupous and diphtheritic stomatitis and of gastritis and croupous enteritis and with the formation of the well-known croupous tubes. Moreover, malignant catarrhal fever may be complicated with inflammatory phenomena of the urino-genital apparatus (nephritis, cystitis and vaginitis of various degrees). The affection of the eyes is of characteristic and differential diagnostic importance (Gerlach). One observes in nearly all cases inflammation of the lids, conjunctivæ, cornea and even of the iris.

It is quite remarkable that in spite of the serious character of the disease, the parenchyma of the internal organs is found to be intact post mortem. Bollinger characterizes this fact as an important differential diagnostic criterion of this disease, as compared with rinderpest. The musculature also, as mentioned by Frank, shows no variations from the normal condition.

Judgment.—In the larger number of cases with which I am acquainted, the meat of animals affected with malignant catarrhal fever was eaten without harm. Likewise in the literature of the

subject there are no statements of injury to human health from eating the meat of animals which had been affected with malignant catarrhal fever.

In my own opinion, therefore, there can be no objection to the sale of the meat as an inferior food material if the symptoms are restricted simply to the respiratory apparatus, for all the post-mortem findings in these cases are in favor of the propositon that the process runs a local course. In cases of complication with croupous enteritis, on the other hand, and with serious inflammatory phenomena in the urino-genital apparatus, the meat is to be considered as highly unfit for food and is to be excluded from the market, for in these cases there is usually a rapid emaciation of the diseased animals.

(c) Pleuro-Pneumonia of Cattle.

General.—Pleuro-pneumonia of cattle, like rinderpest, is of interest chiefly from a veterinary police standpoint. This fact, however, should not prevent the meat inspector from giving careful attention to the disease; for, by means of an expert control of the slaughter of cattle it is possible to render material assistance to the veterinary police in combating pleuro-pneumonia, since the inspection in abattoirs may serve to detect with certainty cases which run an occult course, and hereby to furnish a timely demonstration of concealed foci of pleuro-pneumonia.

Etiology.—Nocard and Roux, by means of a new and excellent culture method, succeeded in obtaining from lungs affected with pleuro-pneumonia micro-organisms, which, according to the statement of both investigators, do not possess the power of producing pleuro-pneumonia, but, like the lymph of pleuro-pneumonia, are capable of producing immunity against pleuro-pneumonia in cattle. Nocard and Roux prepared small sacks of collodion, filled them with bouillon, and, after a previous sterilization, inoculated them with a small quantity of the fluid exudation from the lungs of a beef animal affected with pleuro-pneumonia. When the collodion sacks thus prepared were placed in the abdominal cavity of cattle or small experimental animals, the bouillon became cloudy and under a microscopic examination was seen to contain a pure culture of extraordinarily minute micro-organisms. The dimensions of these micro-organisms were smaller than those of the smallest known bacteria. They are capable of passing through the pores

of a Berkefeld and Chamberland filter, and can not, therefore, be definitely identified, even after a previous staining. Nocard succeeded in rendering cattle insusceptible to pleuro-pneumonia by inoculation with the organisms cultivated "in vivo."

The clinical picture of pleuro-pneumonia offers little of interest to us. Of much more interest are the pathologico-anatomical findings. Pleuro-pneumonia is a chronic, progressive pneumo-pleurisy. It is restricted, as a rule, to one lung (chiefly the left). The most striking feature of the process is the affection of the interlobular tissue, hyperemia, gelatinous infiltration and thrombosis of the lymph and blood vessels. The lobuli which are surrounded by the diseased, greatly enlarged connective tissue strands, uniformly exhibit various stages of hepatization (red, yellow, gray). Moreover, necrotic lobuli (sequestration) may be present, or lobuli which have lost their original structure in consequence of puriform alterations. The pleura exhibits the alterations of fibrinous pleuritis. At first one finds only small foci in the lungs, of the size of a hazel-nut or walnut. Finally, however, the larger portion of the lungs may be attacked by the progressive pathological process. The characteristic symptoms of pleuro-pneumonia are the extensive affection of the interlobular connective tissue and the presence of inflammatory foci of different ages in the pulmonary parenchyma between the diseased interlobular connective tissue strands (marbled hepatization, according to Gerlach). A cross section through a lung affected with pleuro-pneumonia presents no uniform picture, as, for example, is obtained by a cross section through lungs affected with hemorrhagic septicemia of cattle, pneumonia of horses, or swine plague; but always presents to view freshly inflamed foci, together with older ones (see Fig. 4 of the lithographic plate).

Differential Diagnosis.—1. *Genuine Pneumonia.*—In the literature of the subject, we find isolated statements concerning the occurrence of a genuine non-infectious pulmonary inflammation in cattle. This usually occurs on the right side. Genuine pneumonia is distinguished from pleuro-pneumonia by its acute course, and, therefore, by the fact that the alterations in the lungs are all of the same age.

2. *Pectoral Form of Hemorrhagic Septicemia of Cattle.*—In the pneumonia of hemorrhagic septicemia, we also find extensive infiltration of the interlobular tissue and pleuritis. The hepatization of the lungs, however, is uniform and of the same age (as in pneumonia of horses). Moreover, the inoculation of animals furnishes an excellent

differential diagnostic criterion (see under "Hemorrhagic Septicemia of Wild Game and Cattle").

3. *Infectious Broncho-pneumonia of Calves.*—In this disease, the distension of the interlobular tissue is entirely wanting and the pulmonary parenchyma exhibits phenomena of a lobular desquamative pneumonia. The affected parts of the lungs are grayish-red, rich in fluids and free from air. A slimy purulent secretion is found in the bronchi. The inoculation of diseased portions of the lungs does not, as a rule, kill small experimental animals.

Nocard observed, in five steers imported from America, a contagious broncho-pneumonia which aroused a suspicion of pleuro-pneumonia. The disease in question, however, was distinguished from pleuro-pneumonia by its acute character, flabby hepatization and the less extensive infiltration of the interlobular tissue. A considerable quantity of ropy, slimy, purulent secretion escaped from some of the bronchi. In this secretion Nocard found a micro-organism which killed mice, guinea pigs, rabbits and pigeons within forty-eight hours.

4. *Traumatic Pneumonia.*—The differentiation of traumatic pneumonia from pleuro-pneumonia is simple. In cases of traumatic pneumonia, a "marbled" appearance may arise in the tissue surrounding the foreign body in consequence of the extensive affection of the interstitial pulmonary tissue by the process. The easily demonstrable trauma, however, removes all doubt.

5. *Aspergillosis* (see page 325).

JUDGMENT.—Section 85 of the Instructions with regard to the Imperial Animal Plague Law declares that "the lungs of animals killed on account of pleuro-pneumonia, or dead of the disease, must be buried at least one meter deep, in order to render them innocuous. The meat of such animals shall not be removed until it is entirely cooled off."

According to the provisions of the Imperial Animal Plague Law, the sale of the meat of animals affected with pleuro-pneumonia is permitted. The restriction that the meat of such animals shall not be transported until after it is perfectly cool was adopted on account of the fact that it was assumed that a virulence attached to the meat while still possessed of the animal heat.

From a sanitary standpoint, no objection can be raised against the release of the meat as permitted by the Imperial Animal Plague Law, for the meat of animals affected with pleuro-pneumonia is eaten without any bad effects. In cases where the lungs are not

seriously affected, the meat may be considered as marketable. If, on the other hand, the animals are slaughtered during the crisis of the disease in an acute, feverish condition, in which animals subjected to emergency slaughter do not bleed adequately, the meat is to be sold under declaration as an inferior food material. The meat is usually absolutely excluded from the market in cases in which emaciation and edematous processes have developed during the course of the disease.*

In a dissertation prepared under the direction of Jürgensen, Wiedermann propounds the question whether pleuro-pneumonia occurs in man. The occasion for this was given by the post-mortem findings in two children in a region (Lustnau, near Tübingen) in which at the time in question pleuro-pneumonia was very prevalent among cattle. The lungs of both of the children were stated to have exhibited a picture resembling that of pleuro-pneumonia, viz., fibrinous pneumonia and purulent pleuritis, together with pericarditis. No transmission of the virus from eating the milk or by any other method could be demonstrated with certainty in other cases and no confirmation of this observation (1878) has since been furnished, although there has been no lack of opportunities for observation in the districts affected with pleuro-pneumonia for example, in the government district of Magdeburg.

(d) Hemorrhagic Septicemia of Wild Game and Cattle.

Etiology.—This disease, thus named by Bollinger, who first described it, has been explained from an etiological standpoint, especially through the investigations of Kitt. The disease is due to bacteria which are classified with the group of rabbit septicemia (Koch), or of hemorrhagic septicemia (Hüppe). In addition to rabbit septicemia and the septicemia of wild game and cattle, this bacteriological pathogenic group includes also swine plague, buffalo plague and fowl cholera. In order to avoid repetitions, the most important peculiarities of the bacteria in question may here be discussed together.

The organisms of septicemia of wild game and cattle, swine plague, rabbit septicemia and fowl cholera are characterized by

* As in pleuro-pneumonia of cattle, so in infectious broncho-pneumonia of calves and infectious pneumonia of horses, sheep and goats, no injury to health has been observed from eating the meat. With regard to Swine Plague, compare page 695.

their almost complete agreement in morphology, biology and experimental pathogenic properties (Baumgarten) The identity of these bacteria, however, may still be doubted, for the certain proof of identity has thus far been furnished only for fowl cholera and rabbit septicemia (Kitt). The bacteria of this group are about 1 to 1.4 μ long, 0.4 to .7 μ wide, and rounded at the ends (Fig. 239). They are non-motile, and stain most deeply at the poles. They are decolorized by Gram's method. Inoculation with them kills rabbits and mice, as well as pigeons. With regard to other experimental animals, considerable differences exist.

Quite remarkable is the peculiarity of the bacteria of the rabbit septicemia group that they possess, with the exception of the swine plague bacteria, the power of passing through the stomach unattenuated. For the rest, they die in aqueous suspension at a temperature of 55° C. for fifteen minutes, or 80° C. for ten minutes. For the destruction of the bacteria in the meat, however, thin slices must be exposed to a temperature of 80° C. for at least one hour. According to Hüppe, the bacteria in question are killed by being brought to a boiling temperature, a result which, according to Volsch, is not observed in imbedding the bacteria in substrata containing mucin.

Occurrence.—Hemorrhagic septicemia of wild game and cattle occurs in deer, wild boars and cattle. Moreover, the disease is transmissible to horses, hogs and goats, while sheep are infected with difficulty.

Course and Anatomical Findings.—Hemorrhagic septicemia of wild game and cattle appears in three principal forms: As an exanthematic, pectoral and intestinal affection. In the exanthematic form, which is the common form of affection in cattle and which sometimes occurs also in wild game (Lüpke), rapidly appearing swellings of enormous size are formed on the soft parts of the head, neck, and develop with an elevation of the internal temperature up to 42° C. Death may result within six hours. As a rule, however, it does not appear until after twelve to thirty-six hours. The swelling arises in consequence of serous inflammation of the subcutis and submucosa of the mucous membrane of the mouth. After death we find not only swellings, but hemorrhages in the different organs.

In the pectoral form of hemorrhagic septicemia, which is the common form in wild game, one observes the phenomena of an

acute pneumo-pleurisy. This form is characterized by a less rapid course (five to eight days). In addition to alterations in the thoracic cavity, hemorrhages are found, in the pectoral form of the disease, in all parts of the body.

The intestinal form is, as a rule, present in association with the two first-named forms and is characterized by the fact that the feces exhibit a bloody character in consequence of hemorrhagic inflammation of the intestinal mucous membrane, especially of the small intestines.

Differential Diagnosis.—Hemorrhagic septicemia may be confused with anthrax (exanthematic form) and with pleuro-pneumonia (pectoral form). The disease is distinguished from anthrax by the absence of splenic tumor and anthrax bacilli, and from pleuro-pneumonia by the fact that the pulmonary foci are all of the same age. The interlobular connective tissue strands are serously infiltrated and consequently distended. The pulmonary lobules, however, which lie between the infiltrated connective tissue strands always exhibit the same stage of inflammation, and not, as in the case of pleuro-pneumonia, old inflammatory foci side by side with fresh ones. Furthermore, in all cases hemorrhagic septicemia is usually recognized as such by a bacteriological examination and inoculation of animals. In the blood and in the bloody exudations one always finds the above described bacteria in large numbers. Mice and rabbits die within from 12 to 36 hours after cutaneous or subcutaneous inoculation, and exhibit, post mortem, a pronounced laryngo-tracheitis, characterized by a scarlet-red coloration of the mucous membrane of the trachea (Kitt). Moreover, hemorrhagic septicemia—and hereby the disease is distinguished from many other infectious diseases—is transmissible to experimental animals by feeding.

Judgment.—The resistance of the bacteria of hemorrhagic septicemia to the gastric juice has already been mentioned. Nevertheless, the meat of animals affected with hemorrhagic septicemia can not be considered as injurious to health; for the transmission of the disease to man has never been observed. Injuries received in making post-mortem examinations have never been followed by evil consequences and the meat of animals subjected to emergency slaughter has never caused any harm when eaten (Freidberger and Fröhner). In his first communication concerning this interesting disease, Bollinger emphasizes the fact that the meat of diseased

animals had been eaten by men in numerous instances and prepared in various ways without any demonstrable harm. This was confirmed by Franck. Moreover, according to Bollinger, contamination of the hands with the blood while making post-mortem examinations was followed by no bad consequences. A case of illness in a workman after the sting of an insect at a time when hemorrhagic septicemia prevailed extensively could not be definitely referred to infection with the virus of hemorrhagic septicemia. The possibility was not excluded that the case was one of ordinary septic infection. Moreover, the meat of animals which have been affected with hemorrhagic septicemia can not be admitted to the market, since this disease, from a veterinary police standpoint, is classed along with anthrax, and is to be treated like the latter (see page 583).

The buffalo plague (barbone disease) is also classified with the diseases which belong to the group of hemorrhagic septicemia. Buffalo plague usually attacks young animals and runs a course of peracute or acute septicemia with the simultaneous appearance of hot, doughy tumefactions in the region of the larynx. Upon post-mortem examination, the most striking alteration observed is an extensive edema of the neck, face and the base of the tongue. The cause of buffalo plague was discovered by Oreste and Armanni in a micro-organism 0.9 to 1.8 μ long and .4 to .6 μ wide, which, morphologically and biologically, is closely related to the organism of hemorrhagic septicemia. The organisms of buffalo plague are found especially abundant in the subcutaneous edematous swellings, less abundantly in the internal organs, and not at all in the cardiac blood of affected animals. It was demonstrated by von Ratz that the rabbit is extraordinarily susceptible to infection from buffalo plague. Rabbits die within 9 to 15 hours after subcutaneous inoculation. Guinea pigs are more resistant, pigeons still more so, and inoculated chickens and ducks remain perfectly healthy. On the other hand, white and gray mice die in from 19 to 36 hours. The disease may be artificially transmitted to cattle, horses, sheep and hogs. Spontaneous transmission, however, during an outbreak of buffalo plague has been observed only in hogs. According to von Ratz, buffalo plague is most closely related to hemorrhagic septicemia.

(e) Blackleg.

Occurrence.—Blackleg of cattle is a stationary disease. It is observed almost exclusively in so-called blackleg districts and is

only occasionally conveyed to other localities in the transportation of animals already infected. The incubation period is two days. It is worthy of mention that usually only cattle between one and four years of age are affected. Besides cattle, blackleg may rarely attack goats, sheep and horses. Hogs are immune to the disease.

Bacteriology.—Blackleg, as shown by Feser and Bollinger, is caused by the strictly anaërobic blackleg bacillus. On account of its behavior toward oxygen, it is found only in affected connective tissue and muscles and never in the living blood. It may occur, however, in the de-oxydized cadaveric blood.

Blackleg bacilli are 3 to 6 μ long and about 1 μ wide and are characterized by an evident motility. As soon, however, as sporulation begins, they become non-motile (Kitasato). The spores occupy a polar position in the straight, stiff rods and the blackleg spores are characterized by their strong resistance to heat.

Fig. 230

Blackleg bacilli, mostly spore bearing. × 500 diameters.

Kitasato emphasizes the fact that the irregular, shining corpuscles, which may be found in the bacilli while the animal is living, and which are characterized by the fact that they stain better in the ordinary manner than the bacilli themselves, are not spores. "The true blackleg spores (resting spores) are not formed in the animal body until from twenty-four to forty-eight hours after the death of the animal." Pieces of meat taken immediately after death and heated for twenty minutes at a temperature of 65° C. proved to be sterile upon inoculation, while material which was taken two days after death and treated in the same manner killed all the experimental animals by the development of blackleg. According to the experiments of Kitt, blackleg bacilli in dried meat are not destroyed by live steam, but are merely attenuated. Fresh blackleg meat was not sterilized, but was merely rendered somewhat less infectious by boiling one hour in a steamer, and the same is true for dry meat powder after similar treatment for six hours.

Symptoms.—Blackleg infection, as in the case with all diseases caused by anaërobic material, takes place only in the subcutis or submucosa in consequence of injury to those parts. The most important criterion of this almost always fatal disease is the appearance of crackling tumors which contain gas and which extend very

rapidly. The most frequent locations of the tumors are the thigh, neck, shoulder and lower part of the breast as well as loin and sacral regions (Friedberger and Fröhner). Simultaneously there is a serious disturbance of the general condition and a high fever (42° C.).

Anatomical Findings.—The skin over the tumors crackles when stroked and is, as a rule, necrotic. The subjacent subcutis is infiltrated with bloody gelatinous material and the musculature is cloudy and either reddish-brown or black. An abundant accumulation of gas may be demonstrated in the subcutis and musculature. The gas possesses a disagreeably stale odor (chiefly carburetted hydrogen), but no odor of decomposition. The rest of the musculature may be only slightly altered. Numerous hemorrhages are found under the serous membranes. The parenchyma of the liver and kidneys and the myocardium are cloudy. In the thoracic and abdominal cavities, serous effusions mixed with blood may be present. The spleen is intact and the blood shows no alterations.

Differential Diagnosis.—Blackleg may be confused with dermal emphysema of mechanical origin, malignant edema and anthrax.

Dermal emphysema may arise mechanically from injuries of the external skin, trachea and larynx, as well as secondarily in connection with interstitial pulmonary emphysema (see page 321). Emphysemata of mechanical origin gradually progress from the cervical region; the skin does not become necrotic and when an incision is made we do not find any bloody, gelatinous effusions. Finally, no bacilli are demonstrable. In malignant edema, the gases, after necrosis of the skin has taken place, possess the odor of decomposition. Furthermore, in a bacteriological examination, the bacilli of blackleg are distinguished from those of malignant edema by the fact that they are more slender than the latter and never develop into threads in the carcass. Spore formation in blackleg bacilli occurs only in a polar position (drum-stick form) and not in the middle as in the bacilli of malignant edema.

With malignant edema is associated a so-called parturient blackleg (Carl). This rarely occurs in blackleg regions, but frequently in regions in which true blackleg has never been observed. In contrast with true blackleg, it is also frequently observed in old cows. According to Albrecht, parturient blackleg occurs two to five days after parturition and usually causes death within one to three

days. The chief clinical symptoms are fever (41° C. or more), depression, lack of appetite and thirst, and a tumefaction of the external genitals which extends to the sacrum, thigh and back, and crackles on stroking. A foul-smelling fluid is found in the uterus and vagina, post mortem, pronounced reddening of the mucous membrane and edema of the submucous and muscularis coats of the uterus. The emphysematous parts of surrounding tissues are affected with bloody serous or fibrinous infiltration. In two cases of parturient blackleg, Carl demonstrated the bacillus of malignant edema as the cause of the blackleg-like alterations.

The differentiation of blackleg from anthrax should not offer any difficulty in the present state of our knowledge concerning the etiology of both diseases. Blackleg is distinguished macroscopically from anthrax by the crackling tumors, intact spleen and the normal character of the blood. All doubt may be removed, however, by the bacteriological findings, and especially by the inoculation of animals. Rabbits are immune to blackleg and guinea pigs are infected with blackleg only by a subcutaneous injection, while anthrax kills rabbits as well as guinea pigs by mere cutaneous inoculation.

Judgment.—The older veterinary observers have already called attention to the fact that the meat of animals affected with blackleg may be eaten by man without any harm, and that, in contrast with anthrax, infection does not take place in man even in dissecting the carcasses. The meat of animals affected with blackleg is accordingly not injurious to health. Nevertheless, it is always highly unfit for food, for it rapidly passes into decomposition, and while being preserved develops a disagreeable, rancid odor resembling smoked herring (Kitt).

For veterinary police reasons, the carcasses of animals affected with blackleg must be rendered innocuous, since blackleg, like hemorrhagic septicemia of cattle, is, from a veterinary police standpoint, classed with anthrax (page 583).

(f) Braxy.

Nature and Occurrence.—Braxy (braasot of the Norwegians and braxy of the Scots) is an infectious disease of sheep, which runs an acute or peracute course, which begins as a hemorrhagic inflammation of the mucous membrane of the fourth stomach, is accompanied with a pronounced development of gas in the alimen-

tary tract, especially in the stomachs, and in some cases causes the death of the animal by general infection, in others, presumably, by intoxication or dyspnea, due to tympanites (Jensen). The disease for the most part attacks young animals; animals over three years of age are seldom affected with braxy. It is, furthermore, worthy of note that braxy is observed almost exclusively in the winter months and either does not occur at all in the summer or only rarely.

Braxy occurs in an epizootic form on the west coast of Norway, in Iceland, Faroe Islands and in Scotland. According to Gamgee, the annual loss from braxy in Scotland amounts to about 150,000 sheep. In Germany the disease has been identified in Mecklenburg. It is said to occur there quite frequently (Peters).

Etiology.—Credit should be given to Ivar Nielsen for having cleared up the etiology of braxy. In the hemorrhagically altered parts of the alimentary tract and in other organs of affected animals, he found a bacillus 2 to 6 μ long and 1 μ wide, *B. gastromycosis ovis* (Fig. 231). The bacillus is actively motile and is stained by Gram's method. It is often found associated in pairs; seldom, however, in longer chains. The braxy bacillus is anaërobic, grows in gelatin, agar and gelatin-agar, but best on blood-serum-agar and blood-serum-bouillon (Jensen). In the carcass and in artificial nutrient media, the bacillus forms spores, either in the middle or at one pole, and may be transmitted to mice, pigeons, chickens, guinea pigs, rabbits, sheep, calves and hogs by subcutaneous inoculation. At the point of inoculation a hemorrhagic inflammation develops with the formation of gas as in blackleg. Artificial infection of sheep by feeding has not been accomplished. The spores of the braxy organisms are very resistant and withstand boiling heat.

Fig. 231.

Braxy bacilli from the hemorrhagic exudation of a subcutaneously infected guinea pig. × 500 diameters.

Clinical Symptoms.—Sheep become suddenly sick, exhibit weakness, usually lie down and are unable to stand again. This comatose condition persists for a few hours and leads almost uniformly to death.

Post-mortem Findings.—The carcasses of dead animals are much bloated. The wool is so loose that it may be rubbed off

with the hand. The most striking alterations are dark, bluish-red spots in the wall of the fourth stomach. The mucous membrane of this organ is of a dark-red color and shows a bloody or bloody-serous infiltration. Hemorrhagic inflammation may also be present in the first stomachs and to a greater or less extent in the intestines. The parenchyma of the liver and kidneys, as well as the myocardium, are cloudy. Occasionally the spleen is somewhat swollen. The carcasses rapidly pass into decomposition and give rise to a powerful stench.

JUDGMENT.—Braxy runs its course so rapidly that, as a rule, affected animals die. The question of judging the meat of sheep affected with braxy, therefore, possesses no practical interest. It should be remembered, however, that the disease may be carried by means of meat traffic, and that, on account of the resistance of the braxy spores to heat, we are not in a position to destroy the virulence of the meat by boiling. The meat of sheep affected with braxy is, therefore, to be rendered innocuous, for sanitary and veterinary police reasons. It is of interest, however, to note that the meat of sheep which have died of braxy is quite commonly eaten in Scotland, without a single case of illness having appeared in the consumers (Jensen). To remove the disagreeable odor, the meat is rubbed with salt, washed in water, again salted and smoked. After some weeks, braxy meat, according to the somewhat questionable statements of Scottish informants, is as good or even better than the meat of healthy sheep.

Reindeer Plague.—Reindeer plague, which, in the summers of 1895 and 1896, prevailed among the reindeer herds of the Laps, appears with symptoms resembling blackleg. The subcutaneous emphysema is not so well delimited as in blackleg. Furthermore, on post-mortem examination one finds, in addition to the accumulation of gas in the subcutis, occasionally a fibrinous inflammation of the pleura and peritoneum. In the spleen and pericardial fluid, bacilli are found, which are more slender than the anthrax bacilli and bear an oval spore in the center or at one pole. The bacilli are stained by the Gram method, are aërobic, produce gas and kill mice as well as guinea pigs.

(g) Diphtheria of Calves.

NATURE.—In 1877, Dammann described under the name of "calf diphtheria" a disease of calves, the most conspicuous symp-

toms of which consist in the appearance of croupous deposits and diphtheritic inflammation upon and in the mucous membranes of the mouth and pharyngeal cavities. These alterations may also develop in the esophagus, second stomach, small intestine, nasal cavity, larynx and trachea, and may reach an acute stage. The disease possesses an unusually malignant character; most animals die after four or five days, or after two or three weeks.

Etiology.—According to the investigations of Dammann, the infectious nature of the disease is certain. He succeeded in transmitting the disease to rabbits and lambs. Löffler studied the pathological products of calf diptheria and found in them bacilli which formed large undulating threads, but which were essentially different from the diphtheria bacillus of man.

According to Bang, the bacillus found by Löffler in the caseous foci of calf diphtheria is a widely distributed pathogenic organism and not only has the power of producing the alterations of calf diphtheria in calves, but may also cause necrosis in other domesticated animals and in various organs. Bang, therefore, gave the bacillus the name "necrosis bacillus." It is identical with the organism discovered by Schmorl in an epizootic disease of rabbits, and called *Streptothrix cuniculi.*

The necrosis bacilli are thread bacteria which appear as short or long rods and as threads of 80 to 100 μ in length and 0.75 to 1.5 μ in thickness. The threads are stained with Löffler's blue and with carbol fuchsin, but not by the Gram method. In the necrotic foci the necrosis bacilli are found arranged radially and often in thick bundles like palisades on the boundary between the living and the dead tissue. Inside of the necrotic parts they are not demonstrable, or, if so, only with difficulty. The necrosis bacilli are strictly anaërobic, grow only in blood serum and blood serum agar, and may be transmitted to mice and rabbits by subcutaneous inoculation. In mice a necrosis of the inoculation wound appears with pronounced collateral edema and death after about 12 days. In rabbits, on the other hand, necrosis is progressive and results in death in from 12 to 16 days.

In addition to calf diphtheria, the necrosis bacillus of Bang has been found in panaris of cattle, in dry gangrene of the skin and subcutis of the teats of cows, in multiple necrosis of the liver of cattle, in one form of liver abscess of cattle which arose from necrosis of the liver, in deeply penetrating diphtheria of the small intestine of the calf, in diphtheria of the uterus and vagina, in

embolic necrosis of the lungs,* in cardiac necrosis, one case of which was of embolic and the other of traumatic origin, in wound necrosis of a beef animal, in gangrenous dermatitis, fistula of the hoof, and diphtheria of the colon of a horse, and in necrosing processes in the oral and nasal cavities, lungs and intestine of a hog (see under "Hog Cholera"). M Fadyean and Hamilton found multiple necrosis also in the liver of a sheep and of a mule. Furthermore, the author has repeatedly demonstrated bacillar necrosis of the mucous membrane of the first stomachs of cattle.

Relation Between Diphtheria of Calves and Human Diphtheria.—The assumption of Dammann that calf diphtheria is identical with diphtheria of man is accordingly not substantiated by bacteriological investigations, since no observation whatever has been recorded of the occurrence of true diphtheria in domesticated animals identical with human diphtheria (compare also "Diphtheria of Fowls"). Likewise, inoculation experiments with virus of human diphtheria have given negative results in animals. In no case has a disease been produced in experimental animals similar to human diphtheria. At most there were local affections of the mucous membranes. Friedberger and Fröhner emphasize the fact that similar inoculation experiments with exclusively negative results have been made by Colin in hogs, Harley in dogs, Pentzoldt in rabbits, chickens and pigeons, and Esser in calves.

Judgment.—The necrosis bacillus is characterized by its tendency to localization. In the case of a local necrosis, as in diphtheria of calves, and in the absence of symptoms of septicemia of a secondary nature arising from necrosis, the meat can be admitted to the market as a spoiled (inferior) food material.

In cases of a secondary sepsis, the meat should be treated as a dangerous food material.

(h) Dysentery of Calves.

Among the intestinal diseases of domesticated animals, enzootic, so-called, white dysentery of calves possesses special interest on account of the frequency of its occurrence.

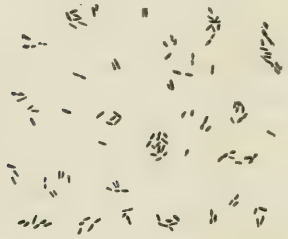
Bacteriology.—Jensen demonstrated that not only in the intestinal contents and the inflamed mucous membrane, but also in

* Embolic pulmonary necrosis in cattle may occasion confusion with pleuropneumonia.

the swollen lymphatic glands and in the blood of calves affected with dysentery, oval bacteria ("calf dysentery bacteria") occur, which in feeding experiments produce fatal dysentery in new-born calves, but in subcutaneous inoculation cause either a local swelling or septicemia. The organism of calf dysentery is morphologically and biologically closely related to *Bacillus coli communis*, *B. neapolitanus* and *B. fœtidus lactis* (Fig. 232).*

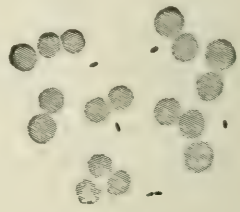
The clinical symptoms of dysentery of calves are well known. Upon post mortem examination one finds advanced emaciation, diffuse red coloration of the mucous membrane of the small intestine and cecum, swelling of the mesenteric glands and often hemorrhages in them, petechiæ under the epicardium and a dirty-red coloration of the skeletal musculature. As a rule, the liver, spleen and kidneys show no gross alterations.

FIG. 232.



Bacteria of calf dysentery from an agar culture 24 hours old. × 500 diameters.

FIG. 233



Bacteria of calf dysentery from a smear preparation from the crural vein of a calf slaughtered in the crisis of dysentery. × 500 diam.

JUDGMENT.—The meat of calves affected with dysentery—that is, of calves which are prematurely slaughtered on account of dysentery—is almost always admitted to the market, and, as a rule, no harm has resulted therefrom. The meat, however, is a spoiled (inferior) food material and should be sold only under declaration. The attention of the purchasers should be called to the fact that the meat must be eaten soon, since it passes into decomposition in a comparatively short time. If calves affected with dysentery are not slaughtered until the agony of the disease, the meat must be considered as a harmful food material, according to present knowledge. At any rate, the harmfulness of the meat of dysenteric calves

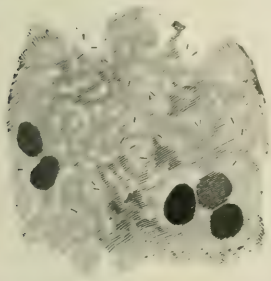
* During his investigations of white scour in Ireland, Nocard found a pasteurella to be the pathogenic organism. Calves become infected at the time of birth, through the umbilicus.—TRANSLATOR.

slaughtered during the agony is connected with the fact that in such cases the specific bacteria are found also in the blood (Fig. 233). Furthermore, the dysentery bacteria may multiply excessively, even at ordinary temperatures, in the carcasses of calves subjected to emergency slaughter (the author). In doubtful cases, therefore, the decision concerning the admission of the meat to the market should be based on a bacteriological investigation (compare page 739).

(i) Swine Erysipelas.

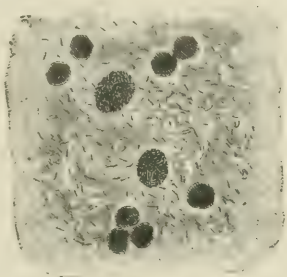
NATURE.—The elucidation of the term "swine erysipelas" is due entirely to bacteriology. Swine erysipelas has nothing in common with erysipelas of man except the reddening of the skin.

FIG. 234.



Swine erysipelas bacilli. Smear preparation from the cardiac blood of an inoculated mouse, stained with fuchsin. × 500 diameters.

FIG. 235.



Same preparation as Fig. 234, stained by the Gram method.

While, however, the erysipelas of man, or traumatic erysipelas, which also occurs in hogs, is caused by *Streptococcus erysipelatis* (Fehleisen), the organism of swine erysipelas is a delicate, slender bacillus, and, for the purpose of differentiation, swine erysipelas is also called "bacillar erysipelas of swine."

BACTERIOLOGY.—The discovery of the swine erysipelas bacillus is due to the investigation of the bacteriologist Loffler, who has done much toward the elucidation of the etiology of animal plagues. As a result of the discovery of the swine erysipelas bacilli, we are in a position to distinguish bacillar erysipelas from the other epizootic diseases of hogs with which it was formerly classified and confused. Further valuable results in the elucidation of the subject

were accomplished by the work of Schütz, Lydtin and Schottelius. The bacilli of swine erysipelas are about 0.8 to 1.5 μ long and .1 to .2 μ wide. They are rendered visible, therefore, only by the use of oil immersion. The bacilli are stained by all the basic analin dyes as well as by Gram's method. By means of the latter stain, it is possible to demonstrate all the erysipelas bacilli present in the preparation (compare Figs. 234, 235). The growth of these bacteria on gelatin is characteristic. Stab cultures at a living temperature, after three or four days, take on the form of a test tube brush. In plate cultures, on the other hand, bluish gray spots appear after two or three days, which under slight magnification exhibit a delicately branched figure (configuration of a bone corpuscle). Spores have not been observed in the erysipelas bacillus. Petri and Maasen demonstrated that the erysipelas bacilli possess to a high degree the power of forming sulphuretted hydrogen. The fact that the growth of erysipelas bacilli does not require a blood temperature explains the fact demonstrated by Lydtin and Schottelius, that erysipelas bacilli in the carcass may multiply to such an extent that within twenty-four to forty-eight hours all the vessels are filled with bacilli.

Susceptibility of Other Animals to Erysipelas Bacilli.—The erysipelas bacilli are transmissible by inoculation to mice, rabbits and pigeons. Horses, cattle, sheep, dogs, cats and guinea pigs, on the other hand, are immune to bacillar erysipelas. At first it was suspected that the erysipelas bacillus of hogs was identical with the bacillus of mouse septicemia, with which it agrees almost completely, morphologically and biologically, as well as with regard to its pathogenicity to mice, rabbits and pigeons. This view, however, can not be sustained, since Preisz has shown that in the inoculation of hogs the erysipelas bacilli are virulent, while those of septicemia are not. Prettner, however, has lately maintained the identity of both species of bacteria on the basis of experimental investigations.

Resistance of Erysipelas Bacilli to Heat and Preserving Re-agents.—The erysipelas bacilli belong to the least resistant micro-organisms. It is difficult, however, to kill the bacilli, with certainty, in meat by means of the common domestic and commercial methods of preparing and preserving. This has been demonstrated by the thorough investigations of Petri. The same investigator reported as follows concerning these investigations:

1. The bacilli of swine erysipelas may usually be killed by heating to 55° C. for five minutes. In some cases, however, they endure a temperature of 70° C. for the same period.

2. In the usual methods of cooking, frying and roasting, the heat penetrated into the pieces of meat very irregularly and slowly even when the period of application of heat was extended to four hours. Bones seemed to conduct the heat into the center of the mass more rapidly than the soft parts.

3. In pieces of meat not heavier than 1 kg. from hogs affected with erysipelas, it was not possible to kill with certainty all the erysipelas bacilli, especially those which were found deep in the muscle or in the bone marrow, by means of the ordinary methods of boiling, frying and roasting. By boiling, for two and one-half hours, pieces of meat which were not heavier than those mentioned above, this result was obtained with certainty, although the same result was not secured by long frying and roasting.

4. The usual salting and pickling materials, common salt, saltpeter and sugar, in a concentrated aqueous solution, affected the germinating power of erysipelas bacilli in pure cultures only slightly and slowly; so that the destruction of the bacilli was not accomplished until after four weeks. Pickling brines containing albumen and other materials obtained from the meat itself exercised a more energetic effect upon the bacteria. The death of the bacteria occurred after about eight days.

5. In the meat of hogs affected with erysipelas, the virus was present in an unattenuated form after salting for one month.

6. In pickling meat covered with brine, the erysipelas virus retained its normal virulence for several months. A slight attenuation appeared after the lapse of this time, but even after six months there were still virulent erysipelas bacilli in the pickled meat.

7. After meat which had been salted or pickled for one month was thoroughly smoked for 13 days, the erysipelas bacilli in pieces of meat freshly removed from the smoke were still unattenuated. It was not until after a further preservation of the meat that the bacilli appeared gradually to lose their virulence. After a period of three months some virulent bacilli could still be demonstrated in smoked hams. In the bone marrow, also, the bacilli retained their virulence for a long time. It was not until after the lapse of six months after smoking that the erysipelas bacilli in hams appeared to have died.

According to Petri, however, boiling small pieces (under 1 kg.) for 2½ hours gives a guaranty that the erysipelas bacilli are destroyed, even in the central parts of the meat.

A certain destruction of the bacilli in the meat of hogs affected

with erysipelas is accomplished by steam sterilization more quickly than by boiling.

Occurrence.—The improved breeds of hogs with light-colored skin are most disposed to erysipelas, while native hogs are least susceptible. In animals under three months of age, erysipelas is rare.

Erysipelas causes annually enormous losses in the national wealth. According to statistics collected in the Grand Duchy of Baden, the number of hogs affected with the disease in that region in the period 1875 to 1884 was not less than 62,568, or 1.8 per cent. of the total number of hogs. Of this number, 7,004 recovered, 15,512 died and 40,052 were slaughtered for meat. In Saxony, the annual loss is estimated to be at least 1.3 to 2.8 per cent.

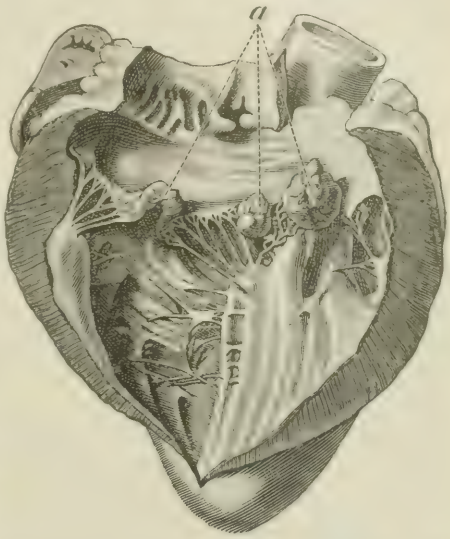
Distribution of Swine Erysipelas by Means of Meat Traffic.—From a veterinary police standpoint, the question whether bacillar erysipelas of hogs can be disseminated as a result of feeding offal and meat or blood of diseased animals is of the greatest importance. Several observations appear to favor an affirmative answer, and Pasteur, Lydtin and Schottelius assert they have produced the disease by feeding erysipelas material. Against these positive results, however, we have the negative results of Petri, who tried in vain to infect three young hogs by feeding erysipelatous organs and parts of meat, although in two experiments he fed 100 gm. of coarsely minced material. Fischer and Bang fed material from acute erysipelas of hogs with similar negative results. Fischer fed the spleen, liver, contents of the stomach and intestines, and excrement without result, while he obtained positive results by confining healthy hogs with diseased ones. It should always be remembered, however, that the erysipelas bacilli disseminated by means of meat traffic may, when set free, acquire an increased virulence under conditions which are thus far not well understood, and may produce outbreaks of erysipelas.

Clinical Symptoms and Pathologico-anatomical Findings.—Bacillar erysipelas of hogs appears suddenly, and, as a rule, quickly leads to death. The essential symptom of bacillar erysipelas, in addition to fever, great depression and weakness, is a red coloration of the skin, which first appears in spots, but rapidly spreads over the whole body. The redness of the skin is characterized by its dark shade.

Upon post-mortem examination of animals affected with erysipelas, one uniformly finds extensive alterations in the internal

organs. In addition to the reddening of the skin and of the panniculus adiposus, there appears extensive parenchymatous degeneration of the liver, heart, and, in a higher degree, also of the kidneys. Hemorrhages are observed under the serous membranes. The spleen is quite swollen and of a bluish-red color. In the stomach and intestines, one observes the symptoms of inflammation in various stages, but, as a rule, bloody, with extensive affection of the lymph follicles in the inflamed area. The lymphatic glands exhibit tumefaction and hemorrhages. Moreover, nephritis of a hemorrhagic character is seldom absent. The kidneys are dark, grayish-red and swollen, and a cloudy, reddish-colored fluid exudes from the cut surface. The symptoms vary, as is readily understood, according to the stage of the disease in which the animals are slaughtered. In animals slaughtered during the agony of the disease, the above described alterations are very pronounced. Moreover, in these cases the musculature is discolored, grayish-red, and, altogether, the internal organs, especially the liver, are very rich in blood.

FIG. 236.



Heart of a hog with valvular verrucose endocarditis as a sequela of swine erysipelas. *a*, warty thickenings.

The carcasses of animals affected with erysipelas, in addition to the above mentioned alterations, possess the further peculiarity that, as a rule, they exhibit either no, or only a slightly pronounced, rigor mortis (Hertwig), and rapidly pass into decomposition.

Bang has given us detailed information concerning an interesting and important sequela of bacillar erysipelas. After Hess and Gillebeau, as well as Schottelius, had called attention to the fact that hogs which recover from natural or inoculation erysipelas may subsequently become affected and die of endocarditis, Bang made the surprising discovery that this endocarditis of hogs which recover from erysipelas is due to a localization of the erysipelas bacilli in the valves of the heart. This endocarditis (Fig. 236) may

reach such an acute stage within two months that it causes death from mechanical causes. The animals either die suddenly or show symptoms of disease for eight to fourteen days. In the latter case a reddening of the skin appears. This, however, in general is less intense than in cases of acute erysipelas. It is worthy of mention, according to Bang, that this reddening of the skin may appear more conspicuously after death than during life. Burggraf demonstrated erysipelatous endocarditis in four out of 30,000 slaughtered hogs.

Differential Diagnosis.—The following diseases may be mistaken for the hemorrhagic infiltration of the skin in cases of bacillar erysipelas: (1) Reddening of the skin from mechanical causes (blows from clubs, whips, etc.); (2) inflammation of the skin from thermic causes (sun's rays, intense cold); (3) traumatic erysipelas; (4) swine plague; (5) hog cholera; (6) urticaria.

Erythrism of the skin from mechanical or thermic causes is always confined to the skin. In extreme cases of blows from clubs, which are, however, distinguished by their characteristic form, the panniculus adiposus may also be colored red in consequence of hemorrhages. The internal organs, however, are always intact. Reddening of the skin from mechanical causes is due to hemorrhages. In cases of inflammation of the skin which appear after prolonged direct action of the sun's rays upon susceptible hogs, we have a reddening which at first is punctate and confined to the skin; later the inflammatory reddening of the skin assumes a diffuse character, but is distinguished from erysipelas by its lighter shade and the complete integrity of the hypodermal fat tissue. Inflammatory phenomena of the skin in consequence of freezing are usually localized on the inferior parts of the body (lower portion of the breast and abdomen, posterior portion of the cheeks). This condition may result in necrosis in cases of prolonged transportation during intense cold.

In cases of defective bleeding, it may occur that stunned and stuck hogs exhibit active movements after being placed in the scalding vat. In such animals one observes a light red color similar to that which is due to the action of the sun's rays and restricted to the unscalded parts of the skin. Brusaffero maintains, furthermore, that he observed hyaline degeneration in the muscles which were not submerged.

Traumatic erysipelas in hogs usually appears in the form of a painful inflammation of the skin about the head and may lead to necrosis. According to Graffunder, erysipelas of the head in hogs

is usually unilateral. When one considers the usual picture of swine plague and hog cholera, it is difficult to understand how these diseases were formerly confused with swine erysipelas. The alterations in the internal organs, especially in the lungs, spleen, intestines and kidneys, are of a totally different sort (page 694 to 703). Moreover, the reddening of the skin which is common to the diseases just named is in cases of swine plague restricted to the deeper-lying parts of the body and possesses a lighter shade of color. Urticaria appears in the form of rhombic, dark-red, elevated areas (Fig. 238). The red spots on the skin do not coalesce. The internal organs are intact.

In all cases erysipelas should be recognized without special difficulty by the course of the disease and the findings at the time of slaughter. For a bacteriological confirmation of the diagnosis, Johne recommends the preparation of a stab culture from the interior of the spleen in addition to the demonstration of the erysipelas bacilli under the microscope. Stab cultures in gelatin show the characteristic form of a test tube brush after a few days (Fig. 237).

Fig. 237

Stab culture of swine erysipelas bacilli in gelatin at a living room temperature (18° C.), 4 days old. Natural size.

Judgment.—It must be considered as demonstrated by experience in hundreds and thousands of cases that the consumption of the meat of erysipelatous hogs is without injurious effect upon man. This fact was emphasized even during the '50's by experienced veterinarians (Nicklas, Hartmann, Straub, Gerlach, *et al.*) at a time when bacillar erysipelas of hogs was still erroneously considered to be anthrax. Hartmann, for example, in his veterinary reports, states that in the government district of Oppeln, the meat of hogs dead of erysipelas was quite commonly eaten by man without any bad consequences being noted. Straub reports that the consumption of such meat is harmless, even when the hogs are affected with erysipelas in an acute stage. The unavoidable conclusion from this enormous mass of experimental material is not altered by the fact that erysipelas bacilli are occasionally found in human excretions (Lubowski), and may be transmitted to man by inoculation (Hillebrandt, Casper). At the end of the '80's, Dieckerhoff, and after

him, Schmidt-Mülheim, expressly emphasized the fact of the harmlessness of the meat of erysipelatous hogs, with special reference to the assumption of the harmful property of the meat in question, which prevailed in medical circles. The necessity for this is best shown by the "extracts from legal decisions concerning the food law," published by the Imperial Health Office. In these decisions, 38 cases are reported in which swine erysipelas gave occasion to criminal procedures. In these 38 cases the meat was considered harmful in 25 cases and a spoiled food material in 9 cases. In 4 cases the opinions of experts were directly contradictory.

In agreement with the opinion rendered by Dieckerhoff, that the meat of erysipelatous hogs, as long as it is fresh and not passing into decomposition, is not harmful to human health, the Royal Prussian Scientific Deputation for the Medical Service, in an opinion rendered November 6, 1889, declared that proof was not forthcoming that the consumption of the meat of erysipelatous hogs was calculated to injure human health.

We must particularly combat the erroneous belief that the bacterial nature of swine erysipelas, in and of itself, indicates the presence of a harmful property in the meat. This is by no means the case, since, according to all experience—infection in man has not been observed in a single case, even after handling erysipelatous meat—the erysipelas bacilli are harmless saprophytes for the human organism.

In so far, therefore, as the meat of erysipelatous hogs does not give evidence of a badly spoiled condition as a result of advanced stage of the disease (intense reddening of the skin and of the panniculus adiposus, discoloration of the musculature, etc.), it may be sold as an inferior food material under declaration. This is to be permitted especially in cases where the animals were slaughtered in an early stage of the disease. Declaration is to be required, however, in all cases in the sale of erysipelatous meat, since it comes from badly diseased animals, and, in contrast with normal meat, possesses much poorer keeping qualities, even when the specific alterations are not especially pronounced.

Regard for the prophylaxis of the bacillar erysipelas of hogs requires that the meat of erysipelatous animals shall be admitted to market only in a cooked or sterilized condition. For, while bacillar erysipelas is pre-eminently a stationary disease, restricted to certain localities, there is a possibility that an opportunity may be given for the dissemination of the disease through the unregulated sale of the raw meat of erysipelatous animals. It is imma-

terial in this connection whether the infection of hogs takes place through the feed, the water used for washing the meat, or by other means.

The Royal Saxon Commission for the Veterinary Service recommended, for preventing bacillar erysipelas, the compulsory boiling or pickling of the meat of animals subjected to emergency slaughter and intended for sale. It has already been stated, however, that pickling does not have the effect ascribed to it by the Saxon Commission. Pickling may be permitted merely as a temporary method of treating meat in localities in which erysipelas occurs in an epizootic form and where, consequently, the utilization of the meat in a cooked condition is impossible. Furthermore, pickling in cities is unobjectionable, since here traffic in meat can not give rise to the dissemination of erysipelas bacilli in hog yards, as would be the case in country districts.*

The Danish Government has ordered that erysipelatous hogs, against the consumption of which the veterinarian raises no objection, shall be used for food only within the limits of the infected locality. In order to avoid the danger of dissemination of erysipelas by means of the meat of infected animals, it was also ordered that permission for the sale of hogs in an infected herd, including those which appeared to be healthy, shall be made dependant upon the proof of the normal character of various parts, including the heart.

The restriction of the consumption of the meat to the infected localities is undoubtedly an effective means of preventing the dissemination of erysipelas bacilli. In cases, however, in which emergency slaughter is performed on a large scale on account of erysipelas, the restriction is practically the same as an absolute destruction of the meat, since the owners, especially in summer, are not able to eat all of the meat. In such cases traffic may be conducted by permitting preliminary pickling, since pickled meat is eaten only in a cooked condition, and the erysipelas bacilli are destroyed after a short exposure in the pickling brine (page 685).

(k) Urticaria.

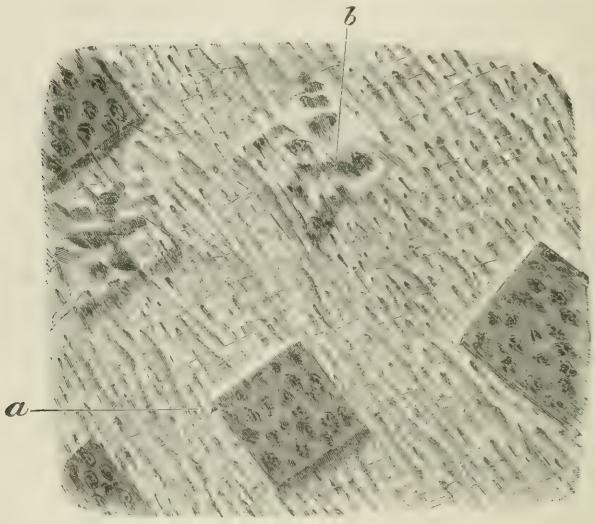
NATURE.—Urticaria ("backsteinblattern," formerly also called "spot erysipelas of hogs") is a disease of swine, characterized by

* By proclamation of the Imperial Chancellor, September 8, 1898, compulsory notification for erysipelas of hogs is required for the whole German Empire.

the eruption of hemorrhagic, diamond-shaped patches. Simultaneously there appear a rather serious disturbance of the general condition, inappetency and obstipation. The diamond-shaped patches are scattered irregularly over the body. Their color at first is dark-red (hemorrhages); later they become pale in the superficial layers, and still later, also in the deeper layers of the tissue.

After slaughter the diamond-shaped patches subside somewhat and exhibit a pronounced rhombic form (Fig. 238). By means of an incision one may be convinced that the disease affects not only

FIG. 238.



Skin of hog affected with urticaria, two-thirds natural size. *a*, rhombic hemorrhagic area; *b*, area disappearing.

the skin, but extends quite deeply into the panniculus adiposus. When the diamond-shaped patches begin to heal, they become round and lose their sharp delimitation from the surrounding tissue.

ETIOLOGY.—Lorenz in Darmstadt demonstrated bacilli in the diamond-shaped patches which, according to Hessian usage, he designated as "backsteinblattern." They possessed great similarity with those of mouse septicemia and erysipelas. According to a private communication, Lüpke, independently of Lorenz, succeeded in producing urticaria-like eruptions by the intravenous

inoculation of the bacilli of mouse septicemia. Simultaneously with Lorenz and Lüpke, Jensen found bacilli in cases of urticaria. Jensen, however, did not consider them a distinct species, but held them to be merely erysipelatous bacilli. Jensen drew the conclusion that bacillar erysipelas of hogs can no longer be considered as a simple process. According to our present knowledge, erysipelas appears in several different, well-characterized forms, between which, however, transition forms sometimes occur. Jensen distinguishes the following clinical forms of bacillar erysipelas: (1) "rouget blanc;" (2) erysipelas in the narrower sense; (3) diffuse necrosing inflammation of the skin (dry gangrene of the skin); (4) nettle fever (urticaria); (5) bacillar verrucose endocarditis. With regard to "rouget blanc" of the French, he remarks that this disease does not often occur and runs its course very rapidly, without any red coloration. Even on the carcass, the skin in cases of "rouget blanc" possesses its normal character.

JUDGMENT.—The meat of hogs which have been affected with urticaria is everywhere admitted to the market after the removal of the diseased spots. As in cases of erysipelas, no injury to human health has been observed. In the more acute forms of the disease, the meat is to be treated as an inferior food material.

For the rest, meat inspectors will do well, on account of the depreciation of the value of the meat in by far the larger number of cases, to advise against emergency slaughter of animals affected with urticaria, since the disease commonly ends in recovery, especially if suitable therapeutic measures (administration of cathartics) are taken.

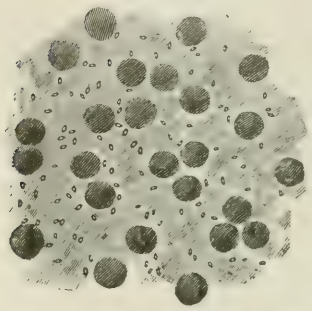
VETERINARY POLICE TREATMENT OF URTICARIA.—Opinions vary on the question whether urticaria, from a veterinary police standpoint, should be treated like erysipelas. Against the justification of such a procedure, the objection has been raised that erysipelas can not be produced by inoculation of urticaria material, and, furthermore, that veterinary police measures against urticaria are practically of no importance, and the value of such procedure in any case stands in no relation to the hardships which result from a veterinary police interference. This point of view receives strong support from the more recent investigations concerning the saprophytic occurrence of the organism of urticaria in the intestines of healthy hogs (Olt, Jensen).

(l) Swine Plague.

Nature and Occurrence.—Swine plague is an infectious disease of hogs which is produced by micro-organisms similar to those of hemorrhagic septicemia of cattle (compare page 671).

According to an observation of Löffler, swine plague may appear as septicemia with serous infiltration of the subcutis. Usually, however, it occurs in the form of a multiple necrosing pneumonia. This is the genuine swine plague, as described and demonstrated bacteriologically by Schütz. As a rule, in addition to pneumonia, there exists a sero-fibrinous pleuritis and pericarditis. The latter affections, however, may constitute the only anatomical alterations of swine plague. Furthermore, a diffuse fibrinous pleuro-peritonitis (pectoral-abdominal form of swine plague, according to Graffunder) is observed, as a result of swine plague.

Fig. 239.



Swine plague bacteria in a smear preparation from the cardiac blood of an infected mouse.

During the acute stage one observes general phenomena in the form of cloudy swelling of the parenchyma of the liver and kidneys, myocardium and skeletal musculature, associated under certain conditions with an enlargement of all the lymphatic glands of the body. Moreover, specific pneumonia, like pneumonia of horses, is frequently ushered in by hematogenous icterus.

The sequelæ of swine plague possess special interest. After the acute inflammatory stage is passed, adhesions of the pulmonary pleura and pericardium with the pleura may occur, as well as adhesions of the pericardium with the epicardium. Moreover, the formation of caseous, purulent and dry necrotic foci (sequestrations) may take place in the lungs.

Differential Diagnosis.—Upon a superficial examination during the acute stage, swine plague may be confused with swine erysipelas, especially since in cases of swine plague a reddening of the skin is observed. Acute swine plague, however, is distinguished from erysipelas with regard to its gross anatomy, by the lighter shade of the red coloration; the restriction of the latter to the

under parts of the body and the absence of splenic tumor and inflammatory phenomena in the intestines. Furthermore, in swine plague the hemorrhagic nephritis which is characteristic of erysipelas is wanting. Finally, however, the presence of the specific alterations in the lungs and on the serous membranes of the thoracic cavity in ordinary cases furnishes a demonstration of the presence of swine plague.

In doubtful cases a decision must be reached by a bacteriological investigation. This is most usually accomplished by making streak cultures, or, if this is without result, by diagnostic inoculation. After inoculation with erysipelatous material, mice and pigeons die, rabbits develop merely typical erysipelas, and guinea pigs remain healthy. With swine plague, however, mice, rabbits, and guinea pigs die within one to three days after inoculation, while pigeons are not affected. Accordingly, in doubtful cases differentiation is made possible by merely inoculating guinea pigs or pigeons (Kitt).

The pneumonia of swine plague is distinguished from catarrhal pneumonia by its fibrinous character, the lobular distension, the greater firmness of the diseased parts of the lungs and the finding of ovoid bacteria which are pathogenic for experimental animals, especially mice.

According to Ströse and Heine, catarrhal pneumonia occurs in one per cent. of the hogs slaughtered in Hanover, causes no pathological symptoms except coughing, and, as a rule, is restricted to a lobular affection of portions of the anterior lobes of the lungs. In the bronchial glands of hogs affected with catarrhal pneumonia, ovoid bacteria could also be demonstrated, but, in contrast with the bacteria of swine plague, they were not pathogenic for mice.

Judgment.—Fiedler and Bleisch are of the opinion that the meat of hogs affected with swine plague should be considered as injurious to health. They state, "We should not fail to mention that as long as the immunity of man toward the bacteria of swine plague has not been demonstrated, the pathogenic action shown in our experiments of the bacteria of swine plague toward different animal genera creates a fear of such action toward man. Especial care in the practice of meat inspection appears to be required with regard to this matter." Against this view is arrayed the experience of meat inspection. Quite aside from the fact that the pathogenic action of the micro-organism in experimental animals proves nothing with regard to man (page 114), before the discovery of the

specific nature of swine plague, the meat of animals affected with the pectoral and intestinal form of the disease was always admitted to the market for the reason that the disease was considered as a simple pulmonary inflammation as a result of colds. Nothing, however, is known concerning injury to human health from eating such meat. To be sure, Pouchet and Zschokke reported observations, according to which the meat of hogs affected with swine plague is said to have exercised harmful effects. These observations, however, are not unexceptionable. In the case reported by Pouchet, the pork was in a state of decomposition, while the case of Zschokke is not clearly explained, and, as the author himself states, was perhaps to be considered as a case of poisoning from saltpeter. Prettner made inoculation experiments on mice with swine plague by rubbing infectious exudations from a hog into skin wounds. The result was negative. Furthermore, an infection of man from handling the altered organs of animals affected with swine plague has never occurred.

If in spite of these facts all scruples against the admission of the meat to the market can not be overcome, at any rate no objection can be raised against the sale of the meat when well boiled or sterilized, since we know that the bacteria of swine plague in pieces of meat which are not too thick are destroyed by exposure for one hour to a temperature of 80° C. In this way, also, the requirements of the veterinary police are satisfied. Such a procedure, however, is necessary only in case of acute swine plague, since in this form bacteria are present in the blood and even in the meat.

The meat of hogs affected with swine plague is to be excluded from the market as highly unfit for food when icterus is associated with an acute stage of specific inflammation of the pulmonary and costal pleura; or when the animals are greatly emaciated in consequence of the disease.*

(m) Hog Cholera.

Occurrence.—Hog cholera is a devastating infectious disease of hogs which has been brought into Europe from the New World. For nearly forty years the disease has been known in America under the names hog cholera and swine fever. The losses from this plague in the United States, for a period of a few years, amounted,

* With regard to compulsory notification of swine plague, see page 702.

according to Schütz, to from twenty-five to thirty million dollars. In 1862 the disease was introduced into England and became stationary there. From England it was carried to Sweden, presumably through the agency of breeding boars, and from thence was introduced into Denmark in 1887. Recently the disease has also appeared in an epizootic form in Germany, especially in Austria-Hungary.

Bacteriology.—Hog cholera is produced by small, motile bacilli which accumulate in the organs in very characteristic masses like the typhoid bacillus. They are stainable with some difficulty. The staining is best accomplished with Löffler's alkaline methylene blue solution, carbol fuchsin, and according to Kuhne's method (carbol methylene blue). Mice, guinea pigs and rabbits are killed by the bacilli within from two to twelve days either by inoculation or by feeding. Hogs likewise die of pronounced cases of hog cholera after receiving the bacilli in food. In animals fed on such material, an extensive enteritis is uniformly present. The mucous membrane of the small intestine is reddened and congested. The intestinal contents are mixed with blood. In chronic cases of the disease there is a localization in the inferior portion of the ileum and cecum in the form of a simple hyperemia or diphtheritic destruction of the mucous membrane. In experimental animals fed on hog cholera bacilli, the organisms are recovered particularly from the intestine, mesenteric glands, liver and spleen. The bacilli of hog cholera are commonly found in the blood of hogs only in cases which run a rapid course and even then are not very abundant.

Fig. 240.

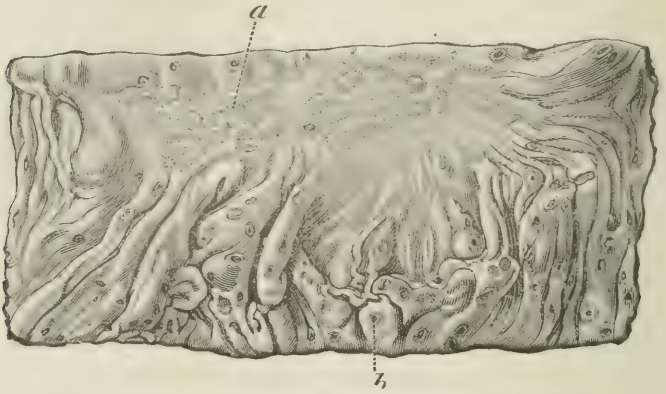
Hog cholera bacillus from an agar culture 24 hours old. × 500 diameters.

Clinical Symptoms.—Hog cholera most frequently attacks young animals, sucking pigs and young pigs up to four months of age. The period of incubation is from five to twenty days. The pathological symptoms are inappetence, slight constipation and, later, a stinking diarrhea. Frequently red spots and a scab-like eczema appears on the ears, snout and in the region of the anus. A purulent conjunctivitis is frequently present. There is rapid emaciation and death takes place after five to eight days, or several weeks with progressive coma. In slight cases of the disease the perceptible pathological symptoms are less pronounced. The ani-

mals which recover are stunted, fail to develop and die after lingering several months.

Anatomical Findings.—Diphtheritic alterations on the tongue, pharynx, gums, and in the stomach; catarrhal, croupous, diph-

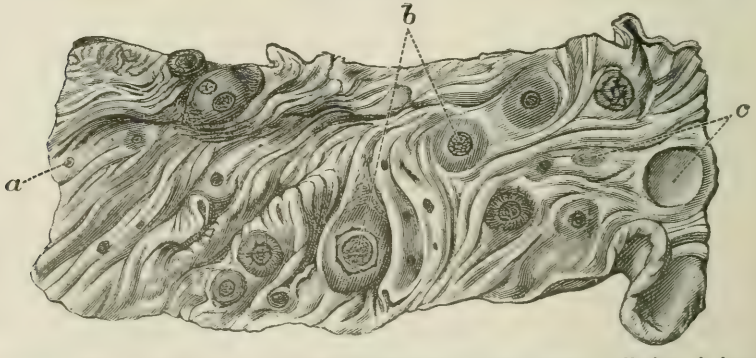
Fig. 241.



Mild case of hog cholera, large intestine of a hog.
a, croupous deposits; *b*, diphtheritic alterations of the lymph follicles.

theritic and hemorrhagic inflammation in the duodenum and ileum. The chief alterations, however, are found in the large intestines.

Fig. 242.



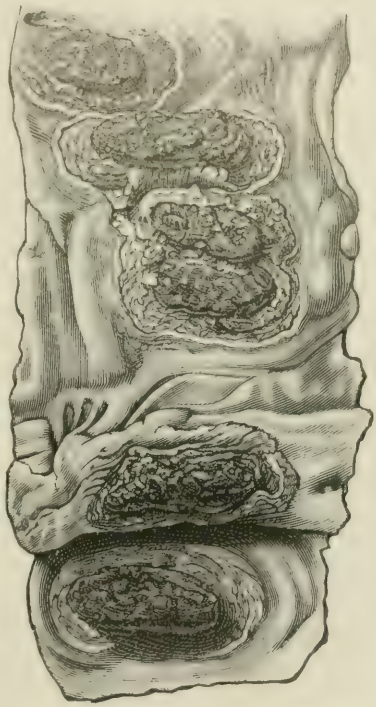
Acute case of hog cholera. *a*, incipient diphtheria of the lymph follicles; *b*, button-like caseous foci with walled borders; *c*, erosions becoming cicatriced.

The surface of the mucous membrane of the cecum, colon and rectum is covered with a croupous deposit (Fig. 241, *a*), or undergoes extensive diphtheritic alteration. The diphtheritic alteration usually

begins in the lymph follicles (Fig. 241, *b*) and changes them together with the surrounding tissue into button-like caseous foci of the size of peas or hazel nuts (Fig. 242, *b*). If the diphtheritic foci are sloughed off, irregular ulcers appear, which may become smoothly cicatrized (Fig. 242, *c*). The ileo-cecal valve is enlarged and casefied in a quite pathognostic form. The lymph glands of the digestive apparatus are simultaneously swollen. The tumefied laryngeal and mesenteric glands may exhibit caseous deposits or may be totally casefied. Calcification is not observed in the caseous products of hog cholera.

The respiratory organs of hogs affected with hog cholera may be perfectly healthy. On the other hand, a pneumonia due to bacteria of swine plague may be associated with hog cholera as a complication; the spleen is unaltered and the liver slightly colored upon cross section. The flabby kidneys exhibit a slightly-clouded cortical substance.

Fig. 243.



Hog cholera. Deep necrotic processes following secondary localization of the necrosis bacillus.

Etiology of Pneumonic and Necrotic Alterations in Hog Cholera.—Bang demonstrated that the different kinds of pneumonia which occur in the chronic form of hog cholera are not produced by the hog cholera bacillus, but by the organism of swine plague, which Bang called the vacuole bacillus and which occurs also in the nasal mucus and in the lungs of healthy hogs. It was also demonstrated by Bang that in case of chronic hog cholera the so-called necrosis bacillus constantly occurs in addition to the hog cholera bacillus and the vacuole bacillus (page 680). The vacuole bacillus is sometimes found in the intestinal contents of healthy hogs and may produce deep necrosing processes in the hog, in which the hog cholera bacillus has already

caused a superficial croupous inflammation. In consequence of the caseation of the mucosa and muscularis, due to the action of the necrosis bacillus, the diseased parts of the intestine are modified into rigid tubes which do not collapse. If the process extends to the serosa, we have a fibrinous or fibrous peritonitis and, during the course of the latter, manifold adhesions between the folds of the intestines. According to Bang, the necrosis bacilli also cause the necrotic processes which are observed in the lungs.

The investigations of Bang on the etiology of the complications which appear with hog cholera have been substantiated by the studies of Preisz, Karlinski and the author.

In isolated cases of diphtheritic inflammation of the stomach and intestines in hogs, Kitt found the necrosis bacillus in unusual quantities in teased preparations and in sections, and he is, therefore, of the opinion that diphtheritic anomalies in the digestive tract of hogs are produced only by the necrosis bacillus and that hog diseases may occur in Germany in a sporadic and epizootic form which closely resemble the American disease clinically and anatomically, but, from an etiological standpoint, have nothing to do with the latter.

Diagnosis and Differential Diagnosis.—The slaughter findings in animals which are affected with hog cholera are, as a rule, so pronounced and characteristic of the disease that the recognition of hog cholera in ordinary cases should present no difficulty whatever to the expert entrusted with the practice of meat inspection. It is only in cases with a peracute course, in which there is merely a bloody inflammation of the stomach and intestines, a swelling of the lymphatic glands with petechiæ in them and the kidneys, that the disease may be confused with swine erysipelas. Such cases, however, are distinguished from erysipelas by the fact that the spleen is not swollen and the kidneys do not show the symptoms of hemorrhagic nephritis. Moreover, the erysipelas bacilli are wanting in the blood and parenchyma, while, on the other hand, the hog cholera bacilli may be demonstrated in the swollen mesenteric glands, by a teased preparation or a culture. In inoculation experiments, it should be remembered that the hog cholera bacilli are comparatively of slight virulence for small experimental animals and that, therefore, the animals may die of intercurrent diseases if other organisms more pathogenic for the experimental animal concerned are accidentally present in the organic material used in making the inoculation.

The distinction between intestinal diphtheria of hogs (Kitt) due merely to the necrosis bacilli and the diphtheria of hog cholera may be made evident only by means of a thorough bacteriological investigation, especially of the mesenteric glands. Since during the course of hog cholera caseous alterations arise in the alimentary tract and its lymphatic glands, there may be a confusion of this disease with alimentary tuberculosis. Hog cholera, however, is distinguished from alimentary tuberculosis by the fact that it is ushered in with acute alterations of the mucous membrane and exhibits only in rare cases pronounced alterations of the lymphatic glands in contrast with tuberculosis. In tuberculosis of hogs, the mucous membrane, even in the acute cases of the alimentary form, are, as a rule, without alterations, while the corresponding lymph glands are always specifically altered to a high degree. The caseous alterations of the mucous membranes in tuberculosis are, moreover, not caused by croup or diphtheria, but represent ulcers, the bases of which consist of disintegrating tubercles (Fig. 243).

A further distinction between hog cholera and tuberculosis is found in the fact that in cases of natural infection, the former produces caseation only in the alimentary tract, while tuberculosis through generalization of the process may cause caseation in most of the internal organs, especially in the lungs, liver, spleen, bones, joints, sheaths of the tendons and the lymphatic glands which belong to these organs.

Finally, the caseation which appears in the lymphatic glands of the digestive tract in cases of hog cholera may be distinguished from tuberculous alterations of those structures by observing the following criteria:

(*a*) Hog cholera produces either a partial or total caseation of the lymphatic glands. The caseous material deposited in them is grayish-yellow and in cases of partial caseation is readily separable from the surrounding tissue of lymphatic glands. Tuberculosis always begins with partial caseation at several points; for it is associated with the pre-existence of numerous small foci or tubercles.

(*b*) The caseations which appear in the lymphatic glands of the digestive organs in case of hog cholera do not become calcified. In cases of tuberculosis of the lymphatic glands of hogs, on the other hand, calcification is uniformly associated with caseation.

(*c*) In cases of partial caseation of the lymphatic glands as a result of hog cholera, the tissue of the lymphatic glands which lies in contact with the caseous deposits commonly exhibits no gross alterations.

In tuberculosis, as shown by Johne, there are always small, perfectly transparent, grayish tubercles, which may be clouded in the center, in the immediate neighborhood of the caseous areas.

These macroscopic criteria are more important in the differentiation of hog cholera from tuberculosis than those which may be secured by bacteriological investigations. For it is a well known fact that in old caseous areas the bacteria of hog cholera as well as those of tuberculosis frequently can not be demonstrated by microscopic investigation, but only by inoculation.

Bang and Jensen have called attention to the fact that the normal condition of the ileo-cecal valve may lead to confusion with hog cholera. In the ducts of the glands of the ileo-cecal valve, yellow cloudy plugs are frequently observed which on superficial examination might be mistaken for caseous foci. These plugs, which arise by retention of the secretion of the glands, may be readily pressed out from the ducts of the glands without losing any of their substance (Fig. 244, *a*). Furthermore, the mucous membrane of the ileo-cecal valve itself is without any alteration.

FIG. 244.

Ileo-cecal valve of a hog. *a*, seat of retention plugs which may give rise to confusion with hog cholera.

JUDGMENT. — A decree of the Royal Prussian Ministers for Agriculture and Education, of July 9, 1894, declares on the basis of the expressed opinions of the Technical Deputation for Veterinary Service and the Scientific Deputation for the Medical Service, that the meat of hogs which have been subjected to emergency slaughter on account of swine plague or hog cholera is not injurious to human health. The decree prescribes the following procedure for the meat in question.

"The meat, however, is to be sold under declaration and in a cooked condition, unless it is eaten on the premises where the disease occurs. The affected internal organs, together with their appendices, are to be buried or burned. The carcasses are to be excluded from the market but admitted for technical utilization in

the case of hogs in which sequelæ, such as icterus or peritonitis, have developed."*

APPENDIX.

The Most Important Infectious Diseases of Fowls.

In connection with the discussion of the diseases of the larger domesticated animals, the two most important diseases of useful domesticated fowls, fowl cholera and diphtheria of fowls, may be briefly considered.

(a) Fowl Cholera.

Occurrence.—Fowl cholera occurs in chickens, geese, ducks, pigeons, turkeys and pheasants and causes enormous losses during the outbreaks. The disease has nothing in common with cholera in man except the name.

Etiology.—Fowl cholera is produced by bacteria which, in respect of their morphology, cultural and pathogenic properties for experimental animals, agree with the organisms of hemorrhagic septicemia of cattle, swine plague and rabbit septicemia (compare page 671).

Symptoms and Anatomical Findings.—The disease is characterized by its rapid, fatal course. The birds die suddenly with apoplectiform symptoms, or show signs of illness for several hours or three days at most. The internal temperature is considerably elevated. Upon a post-mortem examination one finds a hemorrhagic inflammation of the small intestine and a chocolate colored intestinal content; occasionally, also, croupous enteritis, numerous hemorrhages under the epicardium and a congested or inflammatory condition of the lung tissue.

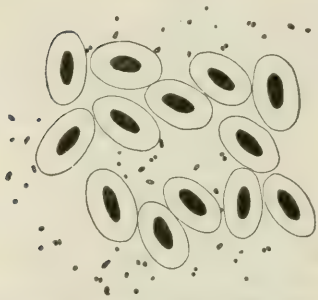
Since the internal organs of diseased and dead fowls are carefully removed before sale, it is not always an easy matter to

* By promulgation of the Imperial Chancellor, September 8, 1898, compulsory notification of swine plague, hog cholera and swine erysipelas, in the sense of Section 9 of the Imperial Animal Plague Law, is introduced for the whole German Empire until further notice, on the basis of Sec. 10^2 of the law.

demonstrate the presence of fowl cholera in the carcasses brought to market. Nevertheless, in fowls which are slaughtered during the agony or which die of the disease cadaveric spots of a dark blue color are commonly found on the inferior surface of the abdomen and on the internal surface of the thigh. The skeletal musculature may appear intact in cases of the disease with an acute course. As a rule, however, it is rich in blood, and, under certain conditions, may be affected with cloudy swelling or may undergo fatty and wax-like degeneration.

Differential Diagnosis.—For confirming the diagnosis it is desirable to examine a drop of blood from the interior of the musculature for the presence of the fowl cholera bacteria, which are 0.3 to 1 μ in length (Fig. 245). Furthermore, Kitt recommends, as a convenient means of confirming the diagnosis, the inoculation of a pigeon by introducing a drop of blood into the musculature of the breast. In cases of fowl cholera, the animals die after twelve or at most forty-eight hours. The disease may be transmitted by feeding, with the same fatal result.

Fig. 245.



Smear preparation from the cardiac blood of a pigeon infected with fowl cholera. × 500 diam.

Judgment.—The infectiousness of fowl cholera is of a limited order. It is transmissible to fowls, rabbits and mice. Guinea pigs die after inoculation only in exceptional cases. In these animals the result of inoculation is, as a rule, local, as well as in horses and sheep. According to the investigations of Perroncito, Marchiafava and Celli, as well as those of Kitt, dogs and cats may with impunity eat large quantities of the raw carcasses of fowls which have died of cholera.

The behavior of man toward the bacteria of fowl cholera requires further elucidation in certain respects. Marchiafava and Celli assert that the bacteria in question may produce abscesses in small skin wounds. This, however, is of little importance. Moreover, according to Zürn, one person was made seriously ill by eating the meat of choleraic chickens. These observations, however, are opposed to numerous others, according to which even the consumption of the meat of fowls dead of cholera was without harm to the consumers.

Perroncito frequently observed servants in his laboratory eating, in a cooked condition, the chickens which had died of the disease, and without experiencing the slightest harm. Likewise, diseased chickens were eaten by the farmers without bad results, during the great prevalence of the disease in Casalgrassa and in the Campagna near Rome. According to Kitt, the same statement is true of the neighborhood of Munich.

In rendering a decision concerning the admission of the meat to the market, it is an important consideration that the disease may be disseminated by means of the carcasses of dead or slaughtered chickens.* The fact just mentioned is sufficient to justify the exclusion from the market of fowls affected with cholera. Moreover, these carcasses, on account of the objective alterations of their substance, frequently exhibit the character of a high degree of unfitness for food.

The sale of the meat of fowls which are slaughtered at the beginning of the disease may be unhesitatingly permitted after previous cooking; for Kitt found that the bacteria of fowl cholera lose their virulence after exposure for three-fourths of an hour to a temperature of 45° to 50° C.

(b) Diphtheria of Fowls.

According to the investigations of Friedberger and Fröhner, we have to distinguish two forms of so-called diphtheria of chickens: one form, probably, produced by bacteria and another form produced by protozoa. The probably bacterial form of roup is, according to Friedberger and Fröhner, next to fowl cholera, the most frequent and most dangerous plague of fowls. It attacks chickens and pigeons, and usually younger individuals of improved races. The essential symptoms of this form of avian diphtheria are croupous, diphtheritic inflammation upon the mucous membrane of the mouth and pharyngeal cavity, or of the respiratory passages (nasal cavity, larynx, trachea), of the eyes, or alimentary tract. The local phenomena are introduced by inflammatory reddening. Thereupon one observes "ropy" and, later, caseous deposits. The clini-

* Notification is required for fowl cholera, according to the proclamation of the Imperial Chancellor's Office, in the Grand Duchies of Baden, Hessen, Mecklenburg-Schwerin, Saxe-Weimar; in the Duchies of Anhalt, Brunswick, Gotha, Saxe-Altenburg, Saxe-Meiningen; and in the Principalities of Waldeck-Pyrmont and Lippe-Detmold.

cal symptoms vary according as there is exclusive or predominating localization of the inflammatory phenomena.

Upon post-mortem examination one finds, in addition to the local alterations, emaciation, anemia, cloudy swelling of the parenchyma and hemorrhages under the epicardium. In the croupous diphtheritic deposits upon the mucous membrane, Löffler demonstrated a bacillus which was pathogenic for mice, and which, when reinoculated into two pigeons, produced a diphtheria of the oral mucous membrane.

Protozoa are claimed by Rivolta and Silvestri as being the cause of one form of avian diphtheria. This form, according to Friedberger and Fröhner, is distinguished from the presumably bacillar form by its ready transmissibility, the milder course of the disease, and the frequent extension of the process from the oral mucous membrane upon the general integument. Upon the latter organ, especially on the featherless parts of the body, from miliary to bean-sized neomorphs (epithelioma, according to Bollinger) appear. These at first are gray, often with a pearl-like sheen, and firm. Later they are covered with a scab and become more elevated.

In the proliferating epithelial cells of the epithelioma, highly refractive homogeneous bodies appear, which stain easily with picrocarmin, and are thereby differentiated from the epithelial cells, which stain brownish-red.

JUDGMENT.—Practically the same statement holds true for the bacterial form of avian diphtheria as was made concerning the so-called diphtheria of calves. The form of diphtheria of fowls produced by protozoa occupies a special position in contrast with this disease, for it is a local disease. The general symptoms in this form are due simply to the mechanical hindrances to ingestion and respiration (compare page 523).

With regard to the bacterial form of roup, Friedberger and Fröhner mention a fact of great importance in the judgment of the meat: viz., that they themselves examined thousands of roupy chickens and pigeons without becoming infected in a single case or without having observed infection in other persons. This fact can be considered as conclusive evidence of the non-transmissibility of the bacterial form of avian diphtheria to man. Nevertheless, the meat of chickens and pigeons which were infected with bacterial diphtheria, in cases where a disturbance of the nutritive condition is present, is to be considered as at least spoiled, if not highly unfit for food.

An opinion of the Royal Prussian Deputation for the Medical Service, of December, 1886, recommends the prohibition of the sale of slaughtered diphtheritic birds and calves, "although the statements of Dr. Emmerich (who claimed to have observed the transmission of avian diphtheria to man) can not be considered as scientific common property." Since the promulgation of this opinion, however, twelve years have passed without bringing any support from observations or experiments to the recommended procedure.

Other Fowl Plagues.—Belfanti and Zenoni described a plague of fowls which caused great losses in Lombardy. It appeared with localization in the respiratory passages (pneumo-pleurisy, pericarditis) or in the alimentary tract (enteritis with splenic tumor). In both cases there were also ecchymoses on the pericardium. Belfanti and Zenoni isolated from the exudations a micro-organism which appeared in the form of oval bacteria and long bacilli.

Recently an intestinal plague of fowls has appeared in Germany, which has nothing in common with fowl cholera, from an etiological standpoint, but is equally as destructive as the latter. The etiology of the new plague is still doubtful.

Gabritschewski reported concerning a spirochete septicemia of geese which appeared in an epizootic form. The disease was ushered in with fever and diarrhea, and resulted in death in 80 per cent. of the cases. At the outbreak of the pathological symptoms, the spirochetæ were demonstrable in the blood; later only in the bone marrow.

Infectious Diseases of Fish.—According to Maurizio, who compiled the literature relating to the fungous diseases of fish and spawn, Unger first described a fungous disease of fish which was probably caused by *Achlya* and *Saprolegnia*. A. Sticker reported concerning fish plagues in the West Indies. Goeppert demonstrated *Leptomitus lacteus* as the cause of an infection of a stream in upper Silesia. Huxley and Murray described a disease of fish, which, during the years 1877 to 1882, became distributed throughout a number of streams of England and Scotland. Walentowicz described a disease of carp in Kaniow and Raciborski determined the pathogenic fungi as *Achlya nowicki* and *Saprolegnia monoica*. *Achyla prolifera* and *Saprolegnia fero* were demonstrated by Blanc and Schnetzler to be the cause of a disease of pike in Lake Geneva in 1887. This fungus is said to have caused a fish disease in the State of New Jersey (Gerard). Maurizio himself frequently observed *Leptomitus lacteus*

on fish and spawn. Finally, attention is called to a bacterial disease of fish described by Emmerich and Weigel which consisted of a furunculosis resulting in septico-pyemia. Wyss examined fish which were dying in large numbers in Lake Zurich. On various parts of the body the fish exhibited circumscribed, pale-yellow spots, varying in size from a silver quarter to a silver dollar. The scales were wanting on the spots or were easily rubbed off. In the blood, bile, liver and intestinal contents, micro-organisms were found which were not found in healthy fish. The organisms were easily cultivated by adding small quantities of the cultures to the water in which fish were living and the disease was easily transmitted to the fish. Fish thus affected soon died with all the pathological symptoms which were observed in cases of spontaneous infection. The micro-organism isolated from the diseased fish was transmissible by inoculation to rabbits, guinea pigs and mice. Fischer and Enoch isolated a rod-shaped micro-organism from the cardiac blood of a carp which had died, presumably from contamination of the water and which was conspicuous on account of the presence of numerous external hemorrhages. The micro-organism was highly pathogenic for cold and warm blooded animals (in corresponding quantities also per os). The rods in cultures as well as in the animal organism produced a toxin (albumose) which caused paresis of the extremities, hemorrhages and paralysis of the respiratory and vasomotor centers. The toxin was destroyed by boiling.

Infectious Diseases of Crayfish—*Crayfish Plague.* — Hofer succeeded in cultivating a bacillus from the muscle meat of diseased crabs, which was 1 to 1.5 μ long, .25 μ thick, rounded at both ends and actively motile. The bacillus is stained by Gram's method, liquefies gelatine and blood serum, and in gelatine plate cultures develops a conspicuous odor of semen and a honey-like odor on blood serum. This micro-organism, as demonstrated also by Weber, kills crabs upon injection even in quantities of 1–1,000 of a Pfeiffer's oese, with symptoms of crab plague (casting of the appendages and the appearance of spasms).

Spot Disease of Crayfish.—In a spot disease of crayfish, which is characterized by the appearance of black spots on the caripace, Happich found a thread fungus (*Oidium astaci*) to be the pathogenic organism. This fungus grows on the ordinary bacterial nutrient media, and, like *Odium lactis*, forms a snow-white aerial mycelium.

Concluding Remarks on Diseases of Food Animals Which Have Not Been Considered.

In the preceding discussion, only the more important diseases of food animals have received a detailed consideration. Other diseases, less important from a standpoint of meat inspection, may be omitted, especially since a sanitary police judgment with regard to them is not a difficult matter, according to the analogy of the groups of diseases to which they belong (organic diseases, blood anomalies, zooparasitic diseases, intoxication diseases and infectious diseases). With regard to diseases of unknown or imperfectly understood nature, however, compare the following chapter concerning "Emergency Slaughter" and "Meat Poisoning."*

* In connection with the chapter on "Infectious Diseases," it should also be noted that a decisive significance in the judgment of meat was formerly attributed to fever when it had been demonstrated in food animals before slaughter. This standpoint, as is apparent from the discussions in Chapter XII, is no longer tenable. It is not the fever which should determine the judgment on the meat, but the disease which causes the fever, since fever is a symptom of numerous diseases, which, from a sanitary standpoint, are to be judged differently.

XIII.

EMERGENCY SLAUGHTER ON ACCOUNT OF SERIOUS INFECTIOUS DISEASES AND MEAT POISONING —ACCIDENTS—DEFECTIVE BLEEDING— NATURAL DEATH.

1.—General Discussion of Emergency Slaughter on Account of Serious Infectious Diseases.

The most important and most difficult part of the duties of meat inspecters is the rendering of opinions on emergency slaughter. It is the most important part for the reason that emergency slaughter, if we disregard so-called accidents, is concerned exclusively with seriously diseased animals, which, on account of the nature of their disease, must, in the large proportion of cases, be excluded from the market. The following figures furnish an instructive conception of the extent of condemnation in emergency slaughter as compared with ordinary commercial slaughtering:

In the Grand Duchy of Baden in the year 1889, 205 large animals were condemned among 129,619 slaughtered in the ordinary way; while 923 out of 6,139 animals subjected to emergency slaughter were condemned, or 100 times as large a percentage. Moreover, 127 small animals out of 392,775 slaughtered in the ordinary manner were excluded from the market, while 107 out of only 1,451 animals subjected to emergency slaughter were condemned, or about 245 times as high a percentage.

The total number of cases of emergency slaughter in Germany is estimated by Lydtin at 160,000 per annum, or 1 per cent. of the total number of animals.

It is not, however, merely the considerable value which we have to save or destroy in emergency slaughter that makes the work of expert inspectors so important in such cases, but the hygienic side is important to a still greater degree. "The experience of the last decade in the line of epidemics as a result of eating the meat of

diseased animals has shown beyond question that at least four-fifths of these numerous cases of diseases are connected with so-called emergency slaughter. This fact, to which attention was called by Bollinger, is, more than anything else, calculated to set in the proper light the great importance of expert inspection in cases of emergency slaughter."

In the Grand Duchy of Baden, from 1888 to 1891, the following numbers of animals, according to Lydtin, furnished meat which was injurious to health :

	Per thousand cases of ordinary slaughter	*Per thousand cases of emergency slaughter*
In large animals	1.6 cases.	128 cases.
In calves	.4 "	4.9 "
In sheep	.2 "	20.2 "
In goats	.8 "	72.5 "
In hogs	.3 "	63.4 "
In horses	14.2 "	44.4 "

The difficulties in rendering an opinion in emergency slaughter are based on the fact that we do not, by any means, have to do always with typical diseases, but in many cases with diseases of doubtful origin (cryptogenetic sepsis). The difficulty in diagnosing these cases has already been referred to in the section on "Septicemia" (page 569).

JUDGMENT.—In the greater number of diseases which give occasion to emergency slaughter, the formulation of general view points for rendering judgment is not possible, except to a limited extent. However, it should be emphasized that, on account of its connection with cases of meat poisoning, the meat of all animals subjected to emergency slaughter is to be considered as highly suspicious, and is to be subjected to a more careful inspection than the meat of animals slaughtered in the ordinary manner. Moreover, the meat of animals subjected to emergency slaughter, on account of infectious disease, and which is admitted for human consumption, should not be admitted to the market freely, but should be sold only under declaration. Compulsory declaration is indicated especially for the reason that in animals subjected to emergency slaughter on account of infectious disease, bleeding is, as a rule, defective. The keeping quality of the meat, as stated in another place (page 130), is thereby affected. It is also a fact, learned from experience, that the meat of animals subjected to emergency slaughter readily passes into decomposition. This bad quality of

the meat from cases of emergency slaughter must be made known to the purchaser, in order that he may eat it in as fresh a condition as possible, and in order that he may avoid the injurious effects which may be produced by eating such meat after it has been preserved for a long time, or made up into sausage.

The materials which served to form the technical basis of the draft of the food law contained the following statement on this point: "It can not be considered as a desirable thing to prohibit absolutely the slaughtering of diseased animals. If, according to experience, the meat of these animals is harmless, slaughter should be permitted, with the proviso, however, that if the meat has suffered a depreciation of its nutritive value or keeping quality in consequence of the disease of the animal in question, this fact must be brought to the knowledge of the purchaser; that is, the meat can be sold only as inferior or diseased meat. Otherwise, the purchaser might be deceived, or might injure his health. The latter case might occur if meat without good keeping qualities should, without knowledge of this fact, be kept by the purchaser for a certain period before eating, like ordinary wholesome meat, and should thereby become spoiled."

As stated by Bollinger, the District Veterinarian, Dinter, in Saxony made the worthy suggestion that legal regulations should require that animals subjected to emergency slaughter should not be dealt in by the ordinary butchers, but should be sold in the community in question under police control. In this manner deception of the consumers by the meat dealers would be effectively prevented.

The most important duty of inspectors in case of emergency slaughter is the determination of animals the meat of which must be considered as dangerous to health, and which, for this reason, must be absolutely excluded from the market. For the proper fulfilment of this duty, an accurate knowledge of the causes of meat poisoning thus far observed is indispensable, because these concrete cases furnish the inspector the best criteria for determining the sanitary police method of procedure in cases of emergency slaughter.

2.—Meat Poisoning.

Cases of meat poisoning (sepsis intestinalis, according to Bollinger; infectious enteritis, according to Gaffky) have occupied the attention of the medical world for several decades. More particularly, Bollinger has repeatedly called attention to the great impor-

tance of meat poisoning in human hygiene. In an address delivered at the fourth session of the German Society for Public Hygiene in Düsseldorf, in June, 1876, Bollinger first emphasized the fact that the pyemiæ and septicemiæ of our food animals are more important, from the standpoint of human health, than anthrax and glanders, since the former are much more frequent than the latter and since the toxins of pyemia and septicemia are not destroyed by cooking. Four years later, in an address before a medical society in Munich, Bollinger stated that this assertion had unfortunately been only too well confirmed, for, since that time, eleven extensive outbreaks of meat poisoning with about 1,600 cases had been observed, the greater part of which were of septic or pyemic nature.

In the latter address, Bollinger collected the literature relating to cases of meat poisoning up to 1880 and reviewed this literature in a critical manner. Shortly before this address, Siedamgrotsky (Lectures for Veterinary Surgeons, third series) laid the foundation for comparative investigations by means of his work on meat poisoning. This work is contained in Bollinger's address, so that we may consider the latter as a comprehensive treatment of the question up to the year 1880.

Bollinger cites the following cases:

1. The outbreak of meat poisoning in Fluntern, Switzerland, in the year 1867, in which 27 persons became ill after eating veal. The calf in question was five days old and had "yellow water" in the joints. The chief symptoms in the human patients were vomition of thin, fluid, green masses, watery stools and great depression. These symptoms were frequently preceded by chills; later the temperature became normal or subnormal. Furthermore, stupor was observed, combined with delirium, or headache, and vertigo in the milder cases. Recovery took place slowly and required from two to four weeks in twelve individuals. One patient died, a man 52 years of age, who had eaten large quantities of the improperly cooked and, in part, almost raw liver. A post-mortem examination of this man disclosed petechiæ under the skin and under the epicardium, in the kidneys, intestines and lungs.

Bollinger assumes that the calf was affected with congenital sepsis or pyemia. According to the experience of the writer, the symptoms resemble those of septic calf lameness, which may appear within a few days after birth.

2. Outbreak of meat poisoning in L. Bregenz, in 1874, after eating the meat of a cow which had been subjected to emergency

slaughter five days after parturition, on account of injuries to the sexual organs and retention of the after-birth, with putrid decomposition. After eating this meat, or the broth made from it, 51 persons were affected, either immediately, or in from 11 to 48 hours. Those who ate the liver were affected most violently. Watery stools of a green color, retching, headache, vertigo and weakness in the limbs were the milder symptoms. In severe cases, vomiting, colikv pains, foul-smelling discharges, inability to stand, a burning sensation in the oral cavity, ringing in the ears, cholera-like feeling, flabby skin and weak pulse. The diarrhea persisted for fourteen days; the weakness and depression, however, persisted longer. No death.

3. Meat poisoning in Griessbeckerzell in May, 1876. The noxious meat came from a cow which had been slaughtered fourteen days after parturition and which was affected with prolapsus uteri and ichorous metritis. Twenty-two persons were affected with acute cerebral symptoms and other symptoms resembling those of cholera. Slow convalescence (two to five weeks). Cooked meat and cooked sausage were also injurious. A twenty-year-old girl, who ate of the dressed meat along with her family, remained well, while all of the others were affected. The girl had drunk brandy before and after eating the poisonous sausage.

4. Meat poisoning in Sonthofen, after eating the meat of a two-year-old heifer which had been subjected to emergency slaughter while in a moribund condition on account of puerperal sepsis. Contrary to the orders of a veterinarian, the ill-smelling meat was sold to a neighbor. Among the ten persons who ate of it, seven became ill. Recovery of all these persons after four days.

It is worthy of note that the unwholesome meat exhibited a high degree of decomposition within four days.

Bollinger emphasizes the fact that in the cases of meat poisoning above enumerated, their connection with the diseases of food animals is self-evident.* This can not be claimed for other cases of

* The observations of Gerlach are also of interest, in which the connection between the diseases of food animals and cases of meat poisoning is obvious.

A fresh milch cow received a severe injury of the udder from a scythe; the wound assumed a gangrenous character and the animal was killed after being seriously ill for two days. Although Gerlach forbade the consumption of the meat, the herder removed a piece, and he and his family ate it. All were affected with general illness, vomiting, diarrhea and extensive weakness.

After eating the meat of another cow, which became very sick after parturition and which had been subjected to emergency slaughter 36 hours later, 46 persons became ill; one patient died. The district physician, who did not believe

meat poisoning. In the cases enumerated below, the virulent character of certain viscera was so apparent that it was necessary to assume a local affection of these organs. In this group Bollinger includes the following epidemics:

1. Meat poisoning in Lahr, in August, 1866. The cause was the meat of a cow which had eaten but little for several weeks, passed bloody urine, and was so emaciated and weak that it was necessary to haul the animal in a wagon to the place of slaughter. The meat of the cow is alleged to have had a good appearance and to have possessed no disagreeable odor. Schwartenmagen was prepared from the meat of the cow, mixed with pork which was known to be of good quality. After the consumption of this preparation, all persons who had eaten of it were affected, about 70 in number, including also those who had eaten only a few ounces. The innkeeper who prepared the schwartenmagen and ate of it, together with three other persons, died. The fact should be emphasized that the schwartenmagen appeared to be of good quality in every respect, and that the consumption of the meat of the cow in all other methods of preparation was without bad effects. Pathological symptoms: Summer-cholera with nervous phenomena, including dilation of the pupils, with diminished sensibility of the iris toward light in severe cases.

Bollinger concludes that the schwartenmagen acquired its peculiar harmful property from the kidneys, which were probably utilized in the preparation of this material.

2. Meat poisoning in Garmisch, June, 1878. Seventeen persons became ill after eating liver noodles and tripe which, contrary to the directions of the meat inspector, had been prepared from the viscera of a cow subjected to emergency slaughter. The cow had been affected with hepatic degeneration and "peritonitis" (according to Bollinger, perhaps ichorous peritonitis). After about 48 hours, headache, chills, summer-cholera, visual disturbances, etc.

The meat, or skeletal musculature, was very slightly or not at all toxic.

3. Meat poisoning in St. Georgen, near Friedrichshafen, from the consumption of the meat of a cow subjected to emergency slaughter. At first this animal had a defective appetite, followed by a pronounced fluid, ill-smelling diarrhea. Eighteen persons were affected. The effects were manifested most quickly and vio-

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in any connection between the outbreak of poisoning and the consumption of the meat, ate some of the meat himself in order to prove the accuracy of his view. He became dangerously sick as a result.

lently after eating leberspatzen. Period of incubation, two to three hours.

In conclusion, Bollinger describes the outbreak of meat poisoning in Nordhausen, which occurred in June, 1876, as a result of eating the meat of a cow slaughtered while in a moribund condition. In all, about 400 persons were affected, one of whom died.

The cow is said to have been sick for four or five days and finally to have become very weak. Very malodorous feces were passed. Most of the patients ate raw sirloin or partly fried meat cakes. The one patient who died ate only raw sirloin. A large number of the persons who ate the meat in a boiled or roasted condition remained healthy.

The outbreak of poisoning in Nordhausen was attributed by the district physician, Dr. Gasenick, and by Gerlach—by the latter, however, with reserve—to anthrax, an assumption which Bollinger rightly rejected. The case of meat poisoning in Nordhausen completely agrees with regard to symptoms with other cases of meat poisoning produced by known and unknown micro-organisms.

An outbreak of meat poisoning in Wurzen (July, 1877) greatly resembled that at Nordhausen. In the course of this outbreak, 206 persons were affected after eating the meat of a cow which ten weeks post partum became affected with mammitis and paralysis of the posterior extremities, accompanied with a high fever. The animal was slaughtered while in a moribund condition. The meat was eaten partly raw, partly cooked and partly as sausage or pickled meat during the four days following slaughter. Some of the meat possessed a bad odor, was of a grayish color, and oleaceous. The symptoms in some cases were exceedingly like those of cholera. Six deaths. The most serious cases appeared after eating the raw meat. "The degree of decomposition corresponded with the acuteness of the disease." Bollinger assumes that the original septic toxin had undergone a post-mortem increase of virulence.

The other cases of meat poisoning described by Bollinger in connection with the two last named epidemics may be dismissed briefly. These are the outbreaks which occurred in Lockwitz and Niedersedlitz in July, 1879. Forty persons were affected after eating raw minced meat from a cow which had been subjected to emergency slaughter on account of torsion of the uterus; also the case of meat poisoning in Middleburg, Holland, in March, 1874, during which 349 persons were affected and six died as a result of eating fresh leberwurst of unknown origin; the case of meat pois-

oning in Neubodenbach from eating fresh knoblauchwurst, the cause being unexplained—Bollinger suspected pyemia in the animal—and finally the poisoning of 13 persons on an estate in Riesa, in June, 1879, after eating the meat of a cow which had been slaughtered on account of mammitis and emaciation.

Reference should be made to the works of Bollinger for information concerning the much-disputed cases of meat poisoning in Andelfingen (1841), Kloten (1878), Birmenstorf (1879) and Würenlos (1880), part of which were considered to be typhoid fever (Griesinger). Bollinger, in agreement with Lebert, Köhler, Liebermeister and Biermer, with regard to the case of poisoning in Andelfingen, combats the view that this outbreak was due to typhoid fever. Bollinger argues in the first place that typhoid fever does not occur in domestic animals, and in the second place, that, especially in the outbreak in Andelfingen, dilation of the pupils and visual disturbances were always present, symptoms which speak against the typhoid nature of this epidemic. In the epidemic at Andelfingen, 450 persons became ill on the occasion of a sängerfest and ten of the patients died. Veal was suspected of being the cause. Difficulties in swallowing and dilation of the pupils were noticeable in the patients. The suspected meat had apparently transmitted its toxicity to beef while stored together. The toxin was not destroyed by cooking. Bollinger is of the opinion that the virulence of the toxin was increased post mortem as a result of packing the meat together while still warm.

The outbreak of meat poisoning in Kloten (June, 1878) is characterized by Bollinger as the most interesting of all cases of meat poisoning. In this case, also, 591 persons attending a sängerfest, other persons who ate the meat from the same abattoir, and, finally, a still larger number in the case of which this was not demonstrated —in all, 657 persons—were affected, with six deaths. According to Bollinger, this outbreak is undoubtedly to be ascribed to the consumption of the meat of a calf one week old, which had either died or was slaughtered during the death agony. Unquestionable symptoms pointed to this conclusion. In this case also the original virulent veal had infected other meat, viz., hams which had been stored together with the former in a wooden vat. Persons who drank plenty of wine were either only slightly affected or remained unaffected.* It is a highly interesting fact, and one not observed in

*In other cases of meat poisoning, it has been observed that persons who have consumed large quantities of alcoholic drinks after eating unwholesome meat have remained well (compare page 714).

any other than a case of poisoning in Kloten, that 55 secondary cases appeared which were not attributable to eating the meat, but to a transmission of the disease by the affected persons. This circumstance confirmed certain observers in the conclusion that the cases were typhoid fever.

In the outbreak of poisoning in Birmenstorf, at least eight patients died. The symptoms resembled those of typhoid fever. The cause was the consumption of the meat of a calf four days old which was affected with "yellow water" (polyarthritis septica). Finally, with regard to Würenlos, it was merely demonstrated that a "large number of persons" became ill after eating unhealthy veal. The symptoms, like the cases just mentioned, resembled those of typhoid fever.

Bollinger concludes his valuable treatise with a statement that there can be no doubt of the fact "that the pyemic and septicemic diseases of food animals bear all the characters of dangerous diseases, and, accordingly, require very different treatment from a sanitary police and prophylactic standpoint than has previously been given to them, to the injury of human health."

The well-founded warning of Bollinger, however, has not received the consideration which it deserves. The best proof of this statement is the fact that cases of meat poisoning are still comparatively frequent occurrences.

The writer has succeeded in compiling the statistics of 85 outbreaks of meat poisoning which occurred during the years 1880 to 1900 with more than 4,000 cases, the larger number of which occurred in Germany. The history of these epidemics is also very instructive from the standpoint of etiology and prophylaxis. It proves anew the especially dangerous character of the meat of calves affected with sepsis in association with umbilical affection, and also of cows which have to be subjected to emergency slaughter on account of inflammatory processes after parturition, or on account of peculiar affections of the intestines and udder. Quite special interest, however, attaches to the history of the cases of meat poisoning during the last twenty years, for the reason that it furnishes the first careful investigations concerning the cause of these epidemics.

The more important of these epidemics are briefly described in the following paragraphs:

1. In the Saxon district Bautzen, on September 1, 1881, a cow died of septic metritis. The throat of the animal was subsequently cut in order to give it the appearance of having been slaughtered.

After eating the meat, which was not inspected, more than 120 persons became ill, but recovered quite soon. The symptoms appeared, as a rule, within two or three days after eating the meat. (König.)

2. In 1881, several families of laborers in the Saxon district of Zittau became ill after eating the meat of a horse which apparently was subjected to emergency slaughter on account of petechial fever. The children were most violently affected. One woman who laid the meat in vinegar before cooking was not affected. No deaths. (Grimm.)

3. In Spreitenbach, Switzerland, in 1881, 30 persons became sick after eating the meat of a cow which had been subjected to emergency slaughter after parturition. (Strebel.)

4. In the same town, 4 persons died after eating the meat of a diseased cow and calf, while in all 15 families were affected. No further details concerning the disease of the food animals were determined. (Strebel.)

5. Meat poisoning in Oberlangenhardzell (Canton of Zürich). Toward the end of June, 1882, two families of four persons each became affected with symptoms of violent gastro-enteritis. All the patients were sick for from two to three weeks. The youngest child of one family, an infant two years old, died on the eighth day in convulsions. The official investigations showed with certainty that the cases of illness in both families were attributable to eating the meat of a calf which had evidently died of a disease.

6. The Saxon district veterinarian, Wilhelm, reported a case of meat poisoning which occurred in the year 1884 and was connected with the sale of the meat of a cow which had been subjected to emergency slaughter two days after a difficult parturition. Ten persons were affected. They recovered, however, within from eight to twenty-four hours. The veterinarian who had declared the meat to be edible was punished for criminal carelessness.

7. Meat poisoning in Lauterbach, 1884. After eating the meat of a cow subjected to emergency slaughter, a large number of persons were affected and three died. The symptoms consisted of headache, vertigo, bodily pains, diarrhea, and, in some cases, vomiting. It was shown that the meat and also the meat broth were poisonous. The cow is alleged to have been affected with a dysenterial enteritis. The animal had suddenly refused to eat, gave no more milk and evacuated "slimy intestinal discharges devoid of vegetable matter." Six days later it became necessary to slaughter the cow. It was alleged that after slaughter merely a

slight erythrism of the intestines was observed. The veterinarian who made the inspection was tried, but not convicted.

8. Meat poisoning in Schönenberg, Switzerland. From June 17 to 19, 1886, about fifty persons became ill after eating the meat of two cows which were slaughtered on the 14th and 15th of that month on account of "dysentery." A man in poor health died from the effects of diarrhea.

9. Meat poisoning in Ludwigshafen-Hemshof. From April 17 to 25, 1886, 90 persons became sick, all of whom had purchased meat sausages from the same butcher. An official investigation showed that this butcher had during the night slaughtered a cow which had been treated by a veterinarian for three weeks on account of retention of the placenta and a malodorous discharge from the uterus. The veterinarian who inspected the meat examined the uterus in a cursory manner exteriorly and gave permission for the free sale of the meat.

The effects of eating the meat began to appear within two or three hours, and in no case later than eighteen to twenty hours. Two persons died.

10. The second outbreak of meat poisoning in Middleburg, Holland. This epidemic, which appeared at the beginning of September, 1887, and which affected 286 persons, was also attributed to the retention of the placenta and a septic metritis which was connected with this condition. The fetal membranes were not ejected until the ninth day. The animal was then butchered while in a moribund condition. The meat is said to have possessed an unusual odor and taste, especially manifest during cooking. The cooking, however, did not destroy the toxin, for the meat broth was noxious. The first effects of eating the meat appeared after a period varying from twelve hours to one or two days.

11. Kühnert in Gumbinnen made a report concerning the sickness of a large number of persons after eating the meat of a cow which could not expel the fetus on account of the abnormal position of the latter, and, therefore, had to be slaughtered. After three days, eight persons were affected and a few days later twenty-six others were affected with a high fever, a burning sensation in the stomach, vomition, pains in the extremities and diarrhea.

12. Meat poisoning in Frankenhausen, May, 1889, with fifty-nine cases and one death. The cow the meat of which was the cause of these cases had been affected with persistent diarrhea. One patient, who died, was affected within one hour after he had eaten 800 grams of the raw meat. The cooked meat was also injurious.

When the cow was slaughtered, merely a partial reddening of the intestines was observed. The appearance of the meat is said to have been good and the spleen, liver and other organs not enlarged.

13. In Richenau, Saxony, in May, 1889, more than 150 persons became ill after eating raw bratwurst and raw minced beef from a cow which was slaughtered while in a diseased condition. Upon cutting up the cow, only a slight gastritis was observed, and, therefore, no scruples were entertained against admitting the meat to market. In this case it was not determined to what extent the warm weather of the month of May favored the formation of toxins. It is worthy of mention, however, that two other cattle in the same stable with the one which was subjected to emergency slaughter exhibited the same symptoms of "slight gastritis" and died of the disease.

14. Meat poisoning in H——, Saxony, 1889, after eating the meat of a cow which was subjected to emergency slaughter and which was said to have shown no evidence of serious disease, but, according to the testimony of one witness, exhibited an ill-smelling, fluid evacuation while being slaughtered. Numerous cases after eating the raw meat. The owner of the cow also became ill.

15. Meat poisoning in Darkehmen, East Prussia, November, 1889. Number of cases, thirty. Cause, a beef animal slaughtered while in a diseased condition and not inspected by a veterinarian. It is a remarkable fact in connection with this case of poisoning, that only the consumption of the meat broth was injurious, while the meat, either in a cooked or roasted condition, did not cause any bad effects (intoxication).

16. At the Tenth International Medical Congress, de Vischer made a report of an outbreak of poisoning after eating the meat of a calf which had died of umbilical arterio-phlebitis (so-called calf lameness). The bad effects were noticed in thirty-one persons and resembled typhoid fever.

17. Meat poisoning in Röhrsdorf, in October, 1885, after eating horse meat, horse meat sausage and cooked horse liver. Nothing was learned concerning the condition of health of the horse from which the injurious meat originated. One horse was said to have been affected with abscesses. The effects of eating the meat appeared in the majority of cases within six hours. Numerous cases; one death.

18. Meat poisoning in Cotta, Saxony, in June, 1889, after eating the meat of a cow which was slaughtered on account of a serious case of mammitis, in which 136 persons were affected, four of whom

died. In the majority of cases the meat was eaten in a raw condition. Roast meat and meat broth, however, produced the same effects. The butcher and his assistant, who ate only a mouthful of appetitwürstchen, were likewise affected. The meat is said to have possessed a good appearance and good odor.

19. The outbreak of meat poisoning in Katrineholm, Denmark, as the result of eating the meat of a beef animal which had suffered from "milk fever" and had to be slaughtered. Of the 115 guests who sat at a table at a family celebration, one-half were affected, the most serious cases being observed in those who had eaten freely of the meat broth. According to all our experience, however, this can not have been a case of so-called parturient paresis, but only an inflammatory form of puerperal fever (septic metritis and its sequelæ).

20. Poisoning from eating horse meat in Altena, November, 1890. Twenty persons bought minced meat from a horse butcher and became ill about twelve hours after eating it. One patient died. The horse butcher in question had slaughtered two horses a few days before, one of them having been found down in the stall and unable to stand. The horse perspired excessively and showed difficulty in respiration, but no loss of appetite.

21. Epidemic of meat poisoning in Kirchlinde and Frohlinde, near Dortmund, in the summer of 1891. After eating the meat of a cow which was affected with a disease imperfectly described as "abdominal inflammation," with an ill-smelling exudation, numerous persons became ill. The meat had been brought to the market contrary to the orders of a veterinarian.

22. Outbreak of meat poisoning in Piesenkam. In the middle of June, 1891, a number of persons became ill after eating blood and liver sausages from a cow subjected to emergency slaughter. One man died. The animal was slaughtered under the supervision of a butcher appointed as inspector. This butcher, in spite of the fact that the cow was affected with gastritis, enteritis and cystitis, declared that the meat was edible, and he himself prepared from the intestines, blood and meat of the cow the sausages which appeared to be so highly toxic. The butcher was punished by three months' imprisonment for failure to call a veterinarian in a case of evident disease.

23. An outbreak of meat poisoning, the etiology of which was not well understood, occurred near the end of November, 1890, in Friedberg, in Hessen. The whole retinue of a land owner, in all, 21 persons, suddenly became ill after eating meat preserved in brine

and which came from a cow which had been slaughtered ten days before, on account of the loss of a hoof, as a result of foot-and-mouth disease. Mixed sausage prepared from the meat of this cow and the meat or viscera of two healthy hogs was also injurious. The fresh meat of the cow was eaten in large quantities in a boiled or roasted condition without any bad effects.

24. In an outbreak of meat poisoning at Corres, five families became ill after eating the meat of a cow which had been subjected to emergency slaughter on account of the sequelæ of foot-and-mouth disease. At first the cow exhibited suppuration of the matrix and coronary band of the hoof; later, emaciation and inability to rise. After slaughter, an abscess of the size of a man's fist was found near the hip joint. Furthermore, all the consumers agreed in the statement that the bone marrow was colored and fluid and readily ran out of the marrow cavities. The symptoms among the affected persons consisted in all cases of violent diarrhea, bodily pains, and, in some cases, included vertigo and fainting.

The outbreak of meat poisoning at Corres is of special interest on account of the fact that it can be attributed with certainty to pyemia.

25. In August, 1892, in Moorseele, in Belgium, about 80 persons, after eating veal, were affected with violent vomiting, accompanied with diarrhea and dullness of the sensorium. The injurious meat was shown to have come from two calves, one of which had died and the other had been slaughtered while in a diseased condition. According to the statement of witnesses, both calves had suffered with acute diarrhea. The intestines of both animals are said to have been dark-red in color and the livers swollen, while the musculature did not exhibit any great variation from the normal condition. It is worthy of mention that the meat was eaten very soon, either on the same evening or on the morning after the death of the animals. It should also be remembered that the meat was eaten in a well-boiled or well-roasted condition, as is the custom with Belgian peasants, to whom raw meat is objectionable. Several persons remained perfectly well, although they had eaten the meat which caused serious illness among their messmates. The period of incubation varied; some of the patients exhibited nausea and diarrhea within three hours after eating the meat; in the majority, however, the symptoms did not appear until after 24 hours. One man was affected after an unsually long period. On August 14 and 15, he ate meat pies made of the poisonous veal and felt well on the

16th and 17th. On the 19th, however, he had to call medical assistance. He died on the same day.

26. In Breslau, October 14–16, 1893, 86 persons were affected with gastro-enteritic catarrh, connected in some cases with vertigo, fever, herpes, lassitude and slow convalescence. These symptoms appeared within three to sixteen hours after eating raw minced beef. All of the persons who had eaten the meat, however small the quantity, became ill. In general, the severity of the symptoms corresponded to the quantity of meat which was eaten. The greatest quantity which was eaten by a vigorous adult male was 125 grams. In all other cases, this quantity sufficed for six persons. One child, who had merely licked the plate, was affected; no death. The period of convalescence was, however, unusually long, in some cases more than six months. The meat appeared to be of a fresh red color, did not smell badly, but to some of the patients had a disagreeable taste. It was shown that the injurious meat came from two cows, one of which was slaughtered on account of an injury received during parturition, and the other on account of "acute inflammation of the liver and watery infiltration of the whole musculature."

27. Outbreak of meat poisoning in the district of Weissenfels. In this region more than 100 persons, one of whom died, became ill after eating meat. The meat, which was eaten in the form of sausage and hash, came from a cow which had to be slaughtered on account of a "hoof affection" as a sequela of foot-and-mouth disease. The symptoms in all of the patients were those of acute gastro-enteritis. Likewise, in one fatal case there were alterations such as occur in acute enteritis. Hyperemia of the brain and its meninges was also observed.

28. In Stollberg a butcher slaughtered a calf suffering from diarrhea and already in a moribund condition, and brought the meat to the market. A large number of persons were affected by eating this meat. One seven-year-old boy died after eating an especially large quantity.

29. In 1894, in Brügge, Belgium, more than 70 persons became ill after eating meat from a calf which apparently had died. The symptoms closely resembled those of cholera. The first symptoms consisted of spasms and vomiting. Two of the patients died.

30. In the spring of 1894, in Gersdorf, an epidemic was observed as a result of eating meat. The symptoms were bodily pain, diarrhea, vomiting, fever, excessive weakness and skin eruptions. The poisonous meat came from a cow which became affected

with peritonitis after parturition and for this reason had to be slaughtered.

31. An outbreak of meat poisoning in Bischofswerda. On May 24–28, 1894, more than 100 persons became ill in this locality after eating knackwurst and mettwurst; in a few cases, also, after eating raw minced beef and cooked beef. The general similarity of symptoms (vomiting, dysentery-like diarrhea, with more or less acute bodily pains, headache, pains in the extremities, vertigo, great weakness, lassitude, depression, burning thirst and fever up to 40° C.) pointed to a common cause. In most cases the effects of eating the meat appeared within from 9 to 20 hours, persisted 2 to 3 days, rarely longer, and all cases terminated in recovery. The convalescent patients complained of a long-persisting, excessive weakness. In some patients it is said that during the course of the disease an eczema appeared on the lips and rapidly healed up. The cause of this epidemic was not explained, since it was impossible to determine the disease with which the suspected beef animal was affected.

32. An outbreak of meat poisoning in Denis. Kuborn made a report concerning an outbreak of meat poisoning in Denis, during which 30 persons were affected and 9 died. The meat came from a cow which had died a natural death.

33. An epidemic of meat poisoning in Gaustadt. In the insane asylum at Gaustadt, near Christiania, 81 among 101 persons who had eaten meat at the same time were affected with fever, vomiting and diarrhea. In a number of cases there was also facial herpes or erythema with subsequent desquamation. Four patients died. In these latter, it was possible to demonstrate only petechiæ under the serous membranes and more or less pronounced symptoms of acute intestinal catarrh, together with small infarcts in the lungs. In one case, in which the disease took a chronic course, there were also numerous ulcers in the colon.

34. An outbreak of meat poisoning in the district of Kempen, in Posen. During the pentecost of 1896, in four localities of the district of Kempen, more than 100 persons became ill after eating pork sausage and meat broth. A majority of the patients were seriously ill, and one man died. The investigation of the outbreak failed to demonstrate the disease affecting the animals from which the meat had been obtained.

35. Meat poisoning in Daber. In this locality 33 persons became ill, a number of them seriously so, after eating the meat of a cow which had been slaughtered on account of diarrhea and great

depression. After the slaughter it was found that the animal was suffering from enteritis. The butcher who, contrary to orders of the veterinarian, J——, by whom the inspection was made, sold the meat not only without declaration, but as "firm, fat steer beef," was condemned to six months' imprisonment on account of a violation of the food law and deception. The veterinarian was also tried, but not convicted.

36. An outbreak of meat poisoning in the Canton of Thurgau. According to Silberschmidt, many persons of the Canton of Thurgau in the spring of 1896 became ill after eating cooked, pickled and smoked pork. The meat was alleged to have come from animals which had been subjected to emergency slaughter on account of a reddening of the skin and symptoms of gastro-enteric catarrh. Seven persons who ate the meat were affected with gastro-enteric catarrh within a few days, and a four-year-old child, previously in excellent health, died after two days with symptoms of acute diarrhea and convulsions.

37. An outbreak of meat poisoning in Sielkeim, East Prussia. In June 13–16, 1896, 41 persons in Sielkeim were affected, 15 of them seriously, with symptoms of summer-cholera, acute bodily pains and excessive weakness. The feces were malodorous and, in some cases, bloody. The symptoms appeared within a few hours to two days after eating the meat. Seven families who ate of the meat were not affected. No death. All the patients recovered by June 22. The district veterinarian, Krüger, demonstrated that the epidemic was caused by the meat of two three-months-old calves which had been slaughtered on account of diarrhea associated with great depression.

38. An outbreak of meat poisoning at Kalk, near Köln. On July 19, 1897, and subsequently, 41 persons in Kalk were affected with summer-cholera associated with disturbances of the general condition. Two died. The most serious cases appeared after eating minced raw meat. A small mouthful of this was sufficient to produce more or less serious illness. The cooked meat was also found to be injurious. The butcher, E——, who brought the toxic meat to market, at first asserted that it came from a healthy cow which had been slaughtered at the cattle yards of Köln. Later, however, it was found that E—— had substituted, in the place of the healthy one, another cow which had been subjected to emergency slaughter on account of diarrhea associated with inappetency and serious disturbances of the general condition. The meat of this cow was shown to have caused the out-

break of meat poisoning at Kalk. E——, who had brought the meat to market without a previous inspection by an inspector, was condemned to three months' imprisonment.

39. An outbreak of meat poisoning in Bülstringen. In an action in the Criminal Court in Magdeburg, it was shown that in Bülstringen, in 1898, 40 persons became affected with gastro-enteritis after eating the meat of a calf which had been subjected to emergency slaughter. A veterinary inspection of the condemned pieces of meat showed that the calf had been affected with diarrhea and inflammation of the joints.

40. An outbreak of meat poisoning in Sirault. In 1898, in Sirault, about 100 persons were affected with vomiting, gastric cramps, colic, diarrhea, evacuation of green, malodorous stools. These symptoms appeared after eating pork. Simultaneously there were chills, headache, formication, twitching of the skin and great thirst. Fever was present only at the onset of the disease. In some patients urticaria and labial herpes were observed. Improvement took place after eight days. In some patients, however, the convalescent period was prolonged for weeks. In three cases the disease ran a fatal course.

The above are the more important epidemics of poisoning as a result of eating meat, which have been reported in the literature of the subject in the last twenty years. Doubtless, however, by no means all cases, even when they affected a large number of persons, have come to public notice. The majority of practicing veterinarians, like the Saxon district veterinarian, Lehnert (Jahresbericht, 1884), could report experiences in this line. Lehnert states that he has repeatedly observed cases in which the meat of cows which have been affected with metritis after parturition and in which the placenta had been entirely or partly retained, caused symptoms of poisoning (vomiting and diarrhea) after the meat was eaten. In many cases, however, the illness persisted for only a few days.

Bollinger stated in a lecture which he delivered at a meeting of the Society for Public Sanitation that "the number of undetermined infections, intestinal infections, the cause of which is chiefly found in the food, is, even in adult persons, much larger than is commonly assumed . . . . As a result of eating meat which comes from diseased, especially septic food animals, pathological conditions are produced, which, with regard to their course and also with regard to their anatomical alterations, show a great variation. All transition stages exist from simple digestive disturbances, gastric catarrh and summer-cholera, to serious febrile attacks, which at

times appear under the form of the so-called pituitous fever, gastric fever, ileo-typhoid or dysentery . . . . To the domain of meat poisoning belong probably many other cases of sickness which assume the form of petechial typhoid or febrile icterus (Weil's disease) . . . . It has been demonstrated by experiments on animals (Kocher) that septic and bacterial toxins may make their way from the alimentary canal into the body and cause serious inflammatory processes (for example, infectious inflammation of the bone marrow) without leaving any trace at the point of entrance."

Prophylaxis of Meat Poisoning.—With regard to the prophylaxis of meat poisoning, the following considerations are to be borne in mind:

1. It is necessary that a decision by a government veterinarian should be required in all cases of emergency slaughter and that empirical meat inspectors who err, as a result of their own arbitrary decisons, should be punished severely.

2. The veterinarian should always perform a careful and detailed inspection of all organs.

3. The veterinarian should not admit the meat to the market unless he is perfectly satisfied concerning the disease of the animal and when, according to existing knowledge on the subject, it can be considered as certain that the consumption of the meat will not cause any injury to health.

4. The meat of all animals subject to emergency slaughter, with the exception of those which, on account of accidents, are slaughtered immediately afterward, is to be sold only under declaration and, wherever possible, at the place of slaughter.

It is, however, a duty of veterinary science, in coöperation with practical veterinarians, to solve the numerous problems connected with cases of meat poisoning which still require an explanation. We must, in particular, attempt to determine all diseases in which there is a possibility of injury to health from eating the meat. These problems, even to-day, belong to the more obscure parts of pathology, although during the last ten years much important material has been collected for explaining these disputed questions. From the history of cases of meat poisoning, we know that certain diseases of female breeding animals, as well as of new-born animals, are of prime importance in the etiology of meat poisoning. We do not know for certain, however, why meat from animals suffering from the disease in question is not always injurious.

Furthermore, the septic and pyemic diseases of cryptogenetic character, especially those mysterious septic diseases of the intestines and udder in cattle, are in urgent need of more exact etiological investigations. Beginnings have already been made by the work of Johne, Gärtner, Gaffky and Paak, Poels and Dhont, Van Ermengem, Flügge, Käusche, Holst, Kuborn, Silberschmidt, Günther, especially by the brilliant investigations of Basenau, which are of greatest importance in rendering a decision on emergency slaughter.

Etiology of Meat Poisoning.—The first bacteriological investigation on the subject of the etiology of meat poisoning was done by Johne. In an outbreak of meat poisoning in Lauterbach, he found a bacillus in the injurious meat which was pathogenic to mice and other experimental animals, and possessed morphological characters quite similar to those of *Bacillus anthracis*. Boström also considered the micro-organism in question to be *B. anthracis*.

Fig. 246.

Bacillus enteritidis Gärtner from an agar culture 24 hours old. × 500 diam.

In the outbreak of meat poisoning in Frankenhausen (page 720), Gärtner demonstrated a bacillus in the meat and inside the blood vessels It was motile, easily stainable, but took the stains most intensely at one pole, the remainder of the bacillus being only slightly stained. Dogs, cats, chickens and sparrows proved to be immune. Mice, rabbits, guinea pigs and goats, however, were affected by inoculation and also per os. *B. enteritidis*, as Gärtner named the organism, produces a chemical toxin which is not destroyed by cooking. This explains the fact that in the case of meat poisoning in Frankenhausen persons who had eaten cooked parts of the meat were also affected. Johne demonstrated *B. enteritidis* also in the meat of the cow which caused the outbreak of meat poisoning at Cotta. Strange to say, however, the bacilli in this outbreak were found only in the connective tissue and not in the blood vessels. Later, Johne isolated the same micro-organism from mettwurst and knackwurst which were condemned on account of their connection with the outbreak of meat poisoning at Bischoffswerda. Mice died within from six to twelve days after being fed material obtained from the sausage, and the bacteria in question were found in large numbers in the spleen and in small numbers

also in the blood and transudations. Karlinsky states that he found *B. enteritidis* in dried mutton which had proved to be poisonous.

In the outbreak of meat poisoning at Röhrsdorf, Gaffky and Paak made cultures of pathogenic micro-organisms from two sausages which were sent to them. These organisms were called "sausage bacillus." The latter was found to be a motile rod which did not stain as well in aqueous staining solutions as after the addition of anilin oil. In stab cultures the sausage bacillus resembles the typhoid bacillus. It is a facultative anaërobe and is killed by flaming. However, it possesses the property of producing pathogenic effects when ingested with food. Mice, guinea pigs and apes proved most susceptible to this method of infection. Gaffky and Paak were unable to demonstrate the sausage bacillus in samples of meat sausage from any other source.

In the outbreak of meat poisoning at Rotterdam, Poels and Dhont found short and extraordinarily delicate rods on the surface of the meat and in the intermuscular tissues. These organisms were much more numerous than other demonstrable bacteria. The Rotterdam bacillus is slowly motile, produces indol, but does not coagulate milk. Intravenous injection of the bacillus in large quantities kills cattle within fourteen hours, and the bacilli have been found in all organs, blood and muscles. When inoculated with small doses ($\frac{1}{3}$ cc.) cattle recovered after a temporary affection and the meat of a beef animal slaughtered four days after such inoculation was eaten by the *personnel* of the Rotterdam Cattle Yards without injurious effect. Another experimental beef animal was killed twenty minutes after the inoculation of a small quantity of the pure culture, and part of the meat was preserved at 20° C. and another part in a refrigerator. Immediately after slaughtering the bacillus was found in the spleen and liver, as well as in the blood vessels in small quantities, while it could not be demonstrated in the muscles, except in their blood vessels. On the other hand, meat which was preserved for seventy-two hours at a temperature of 20° C. was found to be thoroughly permeated with the bacilli.* At the instigation of Poels and Dhont, 53 persons ate of the meat which had been preserved in cold storage, 15 of them were affected with

*This finding is of importance in explaining the fact that meat of animals subjected to emergency slaughter, when eaten soon after slaughter, is often harmless or only slightly harmful, while that eaten later may develop very toxic properties, as a result of the multiplication of the bacilli which has taken place in the meantime.

headache, gastric enteric catarrh and bodily pains. The symptoms appeared within from twelve to eighteen hours after eating the meat. Some of the patients were affected with severe diarrhea.*

In the outbreak of meat poisoning at Moorseele, Van Ermengem demonstrated bacilli, which he called the Moorseele bacillus, in the marrow of the femur of two calves concerned in the case of poisoning. This bacillus was 0.6 to 1.5 μ long, somewhat thick but often slender at both ends. It is commonly grouped together in pairs and rarely forms chains in the tissues. It is surrounded with a glistening zone. The rods are very motile and possess numerous (4 to 8) long flagella which are easily stained with Löffler's flagellum stain. In saccharine media, the bacillus of Moorseele produces gas by a decomposition of the sugar. Neutral milk is not coagulated by the bacillus. The milk becomes clear and after eight to ten days is almost transparent. It becomes slightly brownish at the same time and assumes an alkaline reaction. The Moorseele bacillus proved to be pathogenic for calves, apes, dogs, guinea pigs, rabbits, pigeons and mice by any method of inoculation. In the majority of cases, a more or less severe enteritis with hemorrhages in the lungs, liver and spleen appears after inoculation, and in this case the Moorseele bacillus could always be demonstrated in the organs and blood. The bacillus produces a toxalbumen which is not destroyed by heating to a temperature of 100° or even 120° C. Van Ermengem found a great similarity between his bacillus and *B. enteritidis* of Gärtner. However, the two micro-organisms are not identical. The difference in the appearance of pure cultures and in their behavior toward stains argues against their identity. The bacillus of Moorseele stains homogeneously, while *B. enteritidis* does not.

In an epidemic of meat poisoning in Breslau, Sanitarian Flügge fed parts of the poisonous meat to mice. The animals died after two days with symptoms of severe diarrhea. In the intestines of the animals a pure culture was found of a bacterium resembling *B. coli*. From the intestinal contents and the internal organs of the mice, the same bacteria were isolated which had been found in the poisonous meat. Pure cultures of the bacteria killed mice in two to three days with the same symptoms. The bacterial species in question multiplies rapidly in the organism, but ultimately produces its effect by means of a toxin, for the number of bacteria is not suffi-

* The repetition of this experiment on man does not recommend itself, since the results of such experiments can not be foreseen with certainty.

ciently large to enable them to operate mechanically. Känsche states concerning the Breslau bacillus that he was able to demonstrate it in streak cultures made directly from the meat and that it forms gas in saccharine media and produces a toxin which is not destroyed by boiling the pure culture for two minutes. The rods are from two to three times as long as thick, rounded at the ends, stain readily with the ordinary anilin stains, but are decolorized by the Gram method. They are actively motile, grow on gelatin in a manner similar to the typhoid bacillus. Growth is very luxuriant on potatoes. Indol reaction is negative, and milk is not coagulated. The Breslau bacillus is highly pathogenic for mice and pigeons, less so for rabbits. Dogs and cats are refractory. Cooked pigeon and rabbit meat killed rats and mice with symptoms of intoxication. Bacteria could not be demonstrated in the organisms of these experimental animals. Sterilized bouillon cultures (boiled for two minutes) also proved to be toxic for mice. By means of a tabular comparison of the organisms thus far found in cases of meat poisoning, Känsche showed that the Breslau bacillus is identical with the Moorseele bacillus and perhaps also with the bacillus of Poels and Dhont, but that it was distinct from the other bacilli (Gärtner, Karlinski, Fischer, Gaffky and Paak, and Basenau). Basenau made cultures of "*B. bovis morbificans*" from the meat of a cow which had been slaughtered on account of a disease occurring after parturition. This organism is of the size of the typhoid bacillus (1 to 1.2 μ long and .3 to .5 μ wide), is motile and grows rapidly. It is a facultative anaërobe, grows in and upon meat, forms no spores, and is killed by exposure to a temperature of 70° C. for one minute. *B. bovis morbificans* does not produce toxins. It is pathogenic for mice, white rats, guinea pigs and calves, whether transmitted by inoculation or per os. Later, Basenau demonstrated that this bacillus forms indol, but gives no nitroso-indol reaction with sulphuric acid; that it ferments grape sugar, but not milk and cane sugar; produces volatile sulphur compounds, and possesses considerable reducing power toward litmus. It lives in beef broth for three years, but dies after four days in meat broth containing an excess of common salt, and within ten days on agar containing salt.

In an epidemic of meat poisoning in Gaustadt, Holst isolated a micro-organism from the spleen of three of the patients which died, and from the intestinal ulcers of one. The organism was considered identical with the Moorseele bacillus. The Gaustadt bacillus is very virulent for rabbits, less so for guinea pigs, mice and

pigeons. It kills animals by any means of transmission, including the method per os. The bacillus thrives on all ordinary media, and in bouillon forms toxins which are very virulent for rabbits when injected intravenously. These toxins are not destroyed by cooking. An evident diminution of virulence was often observed. The attenuated bacillus, however, again became perfectly virulent by passage through pigeons.

In an outbreak of meat poisoning in Denis, Kuborn determined *Staphylococcus pyogenes flavus* as the cause of the outbreak. This organism was demonstrated also in five samples of the toxic meat of the cow.*

Silberschmidt investigated the sickness which was observed in a family in the Canton of Thurgau after eating the meat of young pigs. The suspected meat caused no pathological symptoms when fed to experimental animals. On the other hand, the injection of a bouillon culture which had been prepared from the dejecta of one of the patients, and from the meat, killed guinea pigs in nearly all cases in which inoculation was made intraperitoneally. In the dejecta of the patients and in the meat of the pig a short rod with rounded ends was found with 4 or, rarely, 8 flagella of considerable length which were evenly stainable, but which were decolorized by Gram's method. The bacillus was killed when heated to a temperature of 58° C. It did not liquefy gelatin, produced much gas in grape sugar agar, but did not coagulate milk. The odor was slightly sweet and the organism is thereby distinguished from the otherwise similar *B. coli communis.*†

In the epidemic of meat poisoning in Kempen, an examination of the spleen and liver of the persons who died after eating the meat showed the presence of a micro-organism, which Günther, on the basis of his investigations, considered identical with *B. enteritidis.*

Bacteria which are similar to *B. enteritidis* and *B. coli communis* were also demonstrated to be the cause of meat poisoning by Hoefnagel (outbreak of meat poisoning on an estate near Rotterdam), Froidbise (two outbreaks of meat poisoning in Belgium after eating

* Basenau called attention to the fact that the outbreak of meat poisoning in Denis was the only instance in which cocci were found as the cause of disease in the place of bacilli, as in other cases of meat poisoning.

† The outbreak of meat poisoning reported by Silberschmidt proves anew that pickling and smoking are not sufficient to kill pathogenic bacteria in meat. This fact was experimentally demonstrated by Stadler for the bacteria which are found in cases of meat poisoning. Stadler found that bacteria are not killed by ordinary pickling, if they were present in the muscles *intra vitam.*

insufficiently cooked sausages of good appearance), Hermann (outbreak of meat poisoning at Sirault), and Nobèle (outbreak of meat poisoning in Flanders). Hermann demonstrated that the serum of men and animals which had withstood an invasion of the bacillus which causes meat poisoning possesses an agglutinating property in dilutions varying from 1 : 6 to 1 : 400, and Nobèle showed that the serum of human beings who had recovered from a case of meat poisoning in Flanders possessed agglutinating properties, not only toward the bacilli which were obtained from these cases of meat poisoning, but also toward the organisms found in the outbreaks at Moorseele, Geneva, Calmpthout and Sirault, even in dilutions of 1 : 200.

Finally, Basenau made a bacteriological investigation of six cases of a disease in slaughtered animals and thereby obtained a confirmation of his previously-expressed opinion that, as a rule, the pathogenic bacteria which penetrate into the meat of animals *intra vitam* are bacilli. Basenau also demonstrated that some of these bacilli, which he called "meat bacilli" (more properly, meat poisoning bacilli), form toxins which are not destroyed by cooking, while in others, as shown by Gärtner and Van Ermengem, this is not the case.

All the bacilli thus far found in cases of meat poisoning show a great morphological resemblance to *B. coli communis*, but differ from this organism in their biological and pathological characters. Basenau states, therefore, that two views may be held : either all of the bacteria in question arise from one and the same biologically and pathologically variable mother species, or we have to deal with distinct races which preserve their characters within narrow limits. Moreover, from the above-discussed bacteriological studies on the problem of meat inspection, Basenau draws the following conclusion : "In all cases of judgment of the meat of diseased animals, except in cases in which the meat must be condemned without any hesitation, on the basis of a microscopic examination of the animal carcass—or with the aid of the known pathological symptoms—a proper bacteriological investigation will lead in the best and most certain manner to a result which will satisfy all concerned."

Basenau rightly holds the opinion that meat containing only bacteria which die at a temperature of 70° C. and a toxin which is destroyed at 100° C. may be admitted to the market without hesitation, without previous treatment in a steam disinfector.

Aside from the bacteriology of cases of meat inspection, the clinical and pathologico-anatomical characters which are common to

septic diseases are of the greatest importance in the prophylaxis of meat poisoning. The most conspicuous clinical characters are a serious disturbance of the general condition and the great depression of the animals, which is often out of all proportion to the local diseases. From a pathologico-anatomical standpoint, lesions of certain viscera (cloudy swelling and fatty metamorphosis of the liver, heart and kidneys), associated with hemorrhages under the serous membranes, as well as swelling of all lymphatic glands, furnish the most valuable criteria to the veterinary inspector for rendering a judgment in critical cases.

It is precisely because this decision is so difficult that we must consider the duty which has devolved upon us as highly thankworthy. To withhold from the market all the meat in cases of emergency slaughter would mean an unjustifiable waste of animal resources; while, on the other hand, too great leniency in judgment would injure the health and endanger the lives of hundreds of human beings. By a proper performance of our duty we reach the desired goal, namely, the withholding from consumption of only such animals subjected to emergency slaughter as is absolutely necessary. At the same time, however, we extricate the veterinarian from an embarrassing position which can be appreciated only by those who have passed sleepless nights after rendering opinions in cases of emergency slaughter, although experiencing no compunctions of conscience.

By the use of the above mentioned criteria, the expert will not, as a rule, experience especial difficulty in rendering judgment on meat from cases of emergency slaughter. In doubtful cases he may have resort to the bacteriological test mentioned by Basenau, for securing a certain criterion. Cases of meat poisoning will probably not entirely disappear. It may be assumed, however, that they will become very rare. In spite of the greatest conscientiousness, errors in judgment will still occur, since there are limits to human knowledge and power, but, *ultra posse nemo tenetur*.

With regard to the practice of meat inspection in cases of emergency slaughter, a circular letter of the Imperial Commission for Veterinary Service in the Kingdom of Saxony states that inspectors should not render judgment according to the appearance of the meat, since even when possessed of decidedly harmful properties, it may appear perfectly normal. Soon after slaughter, but with a thorough dissection, a careful investigation of all organs should be undertaken. As diseases which have frequently led to meat poisoning, the following are mentioned: Inflammation of the

sexual passages connected with parturition (puerperal; especially inflammations which occur in consequence of lesions or retention of the embryonic membranes), parenchymatous inflammations of the udder with serious febrile conditions; febrile gastro-enteric catarrhs, which, in and of themselves, are not very serious, but in which the tendency to hemorrhages and blood effusions, the redness of the serous covering and mucous membrane of the intestines, swelling of the lymphatic follicles in the latter, the swelling of the mesenteric glands and parenchymatous degeneration (cloudy swelling) of the kidneys, liver and cardiac muscle, however slight these processes may be, indicate an absorption of harmful substances from the intestine into the blood; and, finally, peritonitis and pleuritis, as a result of perforation of the wall of the stomach or intestines, as well as cases of traumatic pericarditis in which the exudation in the pericardium possesses a conspicuously vile odor. Thus, experience has shown that an intoxication of the blood may easily take place from the serous sacs by the absorption of the organic toxins which are formed in consequence of the ichorous (septic) inflammation. Moreover, attention is called to the rapid decomposition of carcasses of animals affected with septic diseases. These processes may be readily recognized by the change in the chemical reaction of the meat. If the meat of animals slaughtered on account of disease shows an alkaline reaction within twenty-four hours after death, the meat is to be considered, in doubtful cases, as unqualifiedly foul, and, therefore, unfit for food. Likewise, in doubtful cases, the unfitness for food of the meat of animals slaughtered on account of disease is unquestionable, if, within forty-eight hours after death, the muscle fibers show under the microscope a loss of their characteristic cross striation, a granular cloudiness and a disintegration into fragments.

If, even after all these view points are considered, doubt arises concerning the fitness of the meat for food, it appears desirable that a decision in the matter should not be reached in summer before twenty-four hours and in winter not before forty-eight hours after slaughter. Experience teaches that within this period in cases of septic and toxic poisoning, such conspicuous abnormal alterations of the meat appear with respect to its color and odor as to furnish sufficient criteria for judging the character of the meat in doubtful cases.

Recent Experience Concerning the Slaughter Findings in Cases of Septicemia and Pyemia of Food Animals.—Hartenstein,

as a result of his experience, lays great stress on the reaction of the musculature in judging cases of emergency slaughter. He rightly asserts that the meat in emergency slaughter may be unhesitatingly declared fit for food if the musculature shows an acid, or at least not an alkaline reaction, and if the heart, intestines and liver are normal. Moreover, with reference to the differential diagnosis of osteomyelitis, Hartenstein calls attention to the fact that the softening and liquefaction of the bone marrow may also be observed in many harmless diseases, in which, however, the marrow does not appear as if clouded with pus, but like yellow vaselin or Provençe oil. Finally, Hartenstein states that he has frequently found a fatty degeneration of the liver in cases in which the clinical symptoms did not lead to a suspicion of sepsis, and that, therefore, importance is to be ascribed to this hepatic alteration only in cases in which the other anatomical characters of sepsis are also present.

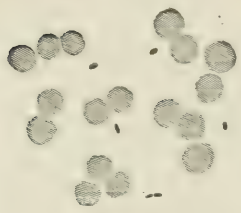
Augst made an important observation, that in obstruction of the esophagus, traumatic pericarditis, acute anemia, and, in general, in all diseases which are ushered in with dyspnea, the musculature does not show its normal acid reaction until twenty-four hours or more after slaughter, but has an alkaline reaction up to that time. Edelmann and Noack made an extensive investigation on the occurrence of alkaline reaction in the meat of freshly slaughtered animals. An alkaline reaction of the musculature was found in 147, or 10 per cent., of 1,474 hogs; 4, or 4.5 per cent., of 89 cattle; 5, or 8 per cent., of 62 sheep; and 5, or 2 per cent., of 251 calves.

In no case did septicemia or pyemia exist. In the majority of cases, the alkaline condition persisted for days, or until decomposition set in. The appearance of an acid reaction in the meat of normal slaughtered cattle and hogs frequently did not occur until after from three to six hours. According to Edelmann and Noack, an abnormal reaction in meat is due to a disturbance of the chemism of the musculature, in which asphyxiating conditions, heart failure, insufficient oxidation of the blood, etc., play an important rôle. Hartenstein made a report on a cow which was slaughtered on account of the appearance of tetanus a short time after parturition, which showed a fatty degeneration of the liver, and an alkaline reaction of the meat from the first to the seventh day. On the seventeenth day the meat was sold on a freibank in a raw condition. Furthermore, Hartenstein found an alkaline reaction of the meat in a cow which was slaughtered on account of tympanites and in another which was slaughtered on account of malignant catarrhal

fever. Since no further suspicious symptoms were present, the meat in both cases was sold on a freibank.

Moreover, according to Augst, all of the lymphatic glands are swollen in cases of sepsis and under certain conditions permeated with hemorrhages. Naturally the lymphatic glands in the region in which inflammatory processes take place (as, for example, the bronchial glands in pneumonia, the mesenteric glands in intestinal inflammations, etc.) do not come into consideration in this connection. Moreover, septic alterations of the lymphatic glands should not be confused with the red coloration of the bronchial glands in cases of blood aspiration, the dark brownish-red coloration of the borders of the corporeal lymphatic glands in cows, and the red coloration of certain follicles and accessory lymphatic glands which occur so frequently in food animals. According to Augst, the lymphatic glands may be altered in the above described manner, while other symptoms of sepsis are wanting immediately after slaughter. However, he never observed swelling of the lymphatic glands without a degeneration of the organic parenchyma in cases of sepsis. Both abnormal conditions exist together. Moreover, the fact should be emphasized that in all cases of sepsis all of the corporeal lymphatic glands are swollen, and that, therefore, no importance is to be attached to the enlargement of a single lymphatic gland.

FIG. 247.



Bacteria of calf dysentery from a smear preparation from the crural vein of a calf slaughtered in the crisis of dysentery. × 500 diameters.

Augst tests the reaction of the musculature by making a deep incision into the musculature of the thigh and pressing a piece of litmus paper moistened with water against the cut surface by means of a knife. This should not be done with the finger, since the finger tips frequently have an acid reaction. After a period of ten minutes the paper is removed from the muscle and laid upon a white substratum and compared with a moistened sample of the original litmus paper. Edelmann and Noack called attention to the fact that the reaction of the musculature may be different in different parts of the body, and that, therefore, in doubtful cases a test of the reaction must be made with different muscle parts somewhat distant from one another.

Augst recommends caution in making a microscopic examination of meat, for he was able to demonstrate granular cloudiness and loss of the transverse striation even in perfectly healthy meat.

Finally, in the meat of animals which Augst did not observe during life, he always applies a cooking test for determining the abnormal odor. For this purpose one-fourth to one-half a pound of chopped meat is boiled with a little water in a closed vessel for one-fourth hour. The cover of the vessel is then lifted and the odors tested.

Augst makes the microscopical examination and the cooking test at home. If, despite this careful preliminary examination, some doubt still remains, he makes another examination of the meat after twenty-four to forty-eight hours, in accordance with the Saxon circular letter (test of the reaction, microscopical examination and cooking test).

Bacteriological Investigation of Meat in Cases of Emergency Slaughter.—In cases suited to this purpose (page 734), Basenau proposed the following bacteriological test of the meat: "It is desirable that the investigation be undertaken twenty-four hours after ordinary or emergency slaughter, for the reason that the bacteria of meat poisoning multiply even at low temperatures and the large numbers which are thus obtained facilitate investigation. In this connection it is naturally supposed that after slaughter the stomach, intestines, etc., are removed in the usual manner. We thus exclude the possibility that bacteria which may be found in the interior of the meat have made their way thither as a result of post mortem invasion from the intestines. For, according to manifold experience, no micro-organisms are found in the meat of healthy animals even when examined a long time after slaughter. Streak cultures and gelatin plate* cultures are then to be prepared from the inside of a piece of meat which contains much loose connective tissue.† Gelatin plates are quite satisfactory for this purpose, provided one uses Forster's gelatin with a high liquefaction point. Simultaneously, two mice should be fed with pieces of raw meat and two others with pieces of meat which have been subjected for one hour to a temperature of 100° C.‡

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*The preparation of gelatin plates may offer considerable difficulty in the practice of meat inspection, especially in the country. It is, however, not absolutely necessary to use them. The determination of bacteria in meat may be made with sufficient certainty by streak preparations on slant agar. Agar tubes may be readily transported in a sterile condition, while gelatin plates can not. For this reason, I recommend streak cultures on slant agar, in place of the plate method described by Basenau for the demonstration of bacteria in meat.

†Poels and Dhont have shown that "meat bacilli" multiply most rapidly in muscles which exhibit a loose intermuscular connective tissue.

"If micro-organisms are not found in the preparations and if no colonies develop in the plates within twenty-four hours, the meat can be discharged without further investigation.

"If the presence of bacteria is demonstrated in the streak cultures or plates, the meat should be preserved temporarily in a suitable manner and the result of the animal experiment, which should be manifest in most cases within at most three days, if the result is positive, will assist in rendering the final judgment. If the mice which are fed with the raw meat die, while those which are fed with meat cooked for one hour do not die, it is apparent that the poisonous property is removed by cooking. According to previous experience, the meat may then be admitted to the market without any danger to human health, after a previous sterilization in a steam apparatus. If no apparatus for sterilization is available, then the simple demonstration of the presence of large quantities of bacteria in the meat is sufficient to justify condemnaton. If the animals fed on the pieces of boiled meat also die, the meat is to be excluded from the market, or at least admitted only for technical purposes. This procedure would be in the spirit of the recommendations of Gerlach, who, several decades ago, stated that the aim of meat inspection should be to protect the health of the consumers and at the same time to utilize as much as possible of the abnormal food animals."

While, up to the present time, no case of meat poisoning has occurred where meat has been inspected in a regular manner, nevertheless, the investigation suggested by Basenau is an important step in advance in the problem of rendering judgment on the meat in cases of emergency slaughter. For, according to the method of Basenau, it becomes possible to admit meat to the market in cases in which, up to the present time, the meat must have been excluded from consumption on account of a presumption of its injurious character.

Technique of the Demonstration of Bacteria in the Interior of Meat.—For the demonstration of bacteria in the interior of meat, a piece of meat is singed with a broad knife heated almost to a glowing temperature; a deep vertical incision is then made into the meat with the sterilized knife. By means of a third and fourth sterile knives, horizontal sections are made and out of the piece

‡ Mice are particularly well adapted for feeding experiments with suspected meat. In all experimental investigations thus far made in cases of meat poisoning, they have proved to be uniformly susceptible to a high degree (Basenau).

thus separated the material is taken for investigation by means of a platinum loop (Forster). The contamination of the interior portions of the meat is thus most effectively prevented, since, according to the investigations of Gärtner and Forster, the meat of healthy animals contains bacteria only to a depth of one centimeter, even after a period of ten days. In a piece of meat which had been preserved in ice for fourteen days, Forster found millions of bacteria on the surface in one milligram of substance, but no bacteria, on the other hand, two millimeters under the surface.*

3.—So-called Accidents.

Slaughter as a result of so-called accidents is to be judged quite differently from the above described cases of emergency slaughter on account of serious infectious diseases. As accidents, we may enumerate bone fractures, serious penetrating wounds of the thorax or abdomen, sudden prolapsus uteri, insuperable obstacles to parturition, injuries to the sexual passages, as well as the frequent cases of bloating after over-feeding with fodder which is readily fermented, and obstructions in the esophagus due to foreign bodies, such as pieces of turnip, apples or potatoes.

In all these diseases, we have to do merely with the effect of purely mechanical causes which destroy the usefulness of the animals in question, or might endanger their life, and which, for these reasons, quite frequently necessitate immediate slaughter.

If, in accidental cases of this sort, the animal is slaughtered immediately after the accident takes place, there is evidently no reason for excluding the meat from the market. It is suitable for food, with the exception of those parts in which the lesions occur.

A wound infection may develop later as a result of the lesion. On account of this possibility, the inspector should undertake a careful intravital and post-mortem examination in all cases in which slaughter is postponed, in order to determine whether wound infection has taken place, and should determine upon the course of procedure according to this examination (see "Septicemia" and

* In the viscera, especially in the liver, as shown by Preuhn, the conditions are quite different. Even within 24 hours, numerous colonies of the coli and proteus bacilli develop in samples taken from beneath the surface, and inoculation experiments in mice caused the death of these animals within one day. In the blood of the inoculated mice, rods of the coli group were demonstrated. These abnormal results are, however, to be attributed to contamination of the organs in slaughtering (laying in water and washing).

"Meat Poisoning"). If wound infection has not taken place, the judgment of the meat with reference to its admission as marketable or inferior food material should be determined largely according to the completeness of bleeding.

The regulation regarding meat inspection in Baden requires compulsory declaration for meat in all cases where animals were not slaughtered immediately after the accident, but only after a period of from six to twelve hours.

Lydtin states that the meat of animals which have been affected with tympanites often possesses a conspicuous red color and a slightly sweetish odor, which appears also in the cooked meat. In such cases the meat is no longer of prime market quality.

It is claimed by butchers that the meat of animals which have been slaughtered on account of insuperable obstacles to parturition is characterized by a poor keeping quality. This fact likewise appears to justify compulsory declaration.

4.—Defective Bleeding.

In many reports concerning the practice of meat inspection, we find among the reasons for condemnation of meat, the phrases "defective bleeding" or "agony." These terms are used in place of the expression "stuck too late," which was previously in vogue. None of these phrases is correct, for the reason that they indicate only one non-essential symptom. A statement of the reason of defective bleeding is much more important, since the judgment must depend thereon.

Defective bleeding may occur in diseased animals, if the heart action is already partly paralyzed, and also in healthy animals, when killed during violent exertion or immediately thereafter; as, for example, in animals which are purposely harrassed or driven long distances on the hoof.

For recognition of defective bleeding, see page 132.

JUDGMENT.—Defective bleeding, as such, requires a sanitary police judgment only in animals which were slaughtered during great exertion or immediately thereafter, and which, therefore, did not bleed freely. In such cases the meat assumes an inferior quality as a food material, on account of the abnormal color due to the high blood content and on account of its well-known poor keeping quality. In order to prevent such occurrences, butchers, of their

own initiative, avoid slaughtering animals immediately after exhausting drives. Moreover, in many cities there are official regulations concerning this matter (compare page 127).

The meat of animals which show defective bleeding on account of diseases is to be judged differently, according to the nature of these diseases.

5.—Natural Death.

Among the domesticated animals most frequently used for food, cattle, sheep, hogs and goats, natural death does not happen with great frequency. The majority of these animals, when threatened with some fatal affection, are killed before natural death has taken place, in order to be able to utilize their meat as human food in all possible cases.

Diagnosis of Natural Death.—Animals which have died a natural death are characterized by the high blood content of all parts, especially of the viscera (liver); by the hypostasis in the inferior parts; fulness of the hypodermal veins; the moist character of the subcutis and musculature; absence of a slaughter or shot wound; and the rapid appearance of decomposition which begins simultaneously upon the surface and in the interior of the meat and viscera.

Judgment.—As in the case of emergency slaughter, so also in the case of dead animals, a general judgment of the meat is impossible, for the reason that diseases of the most various kinds may cause natural death, and judgment must depend upon the diseases which cause death in each case. As a matter of fact, it is usually infectious diseases and septicemia which cause the sudden death of animals, but not all of these diseases render the meat dangerous. Thus, for example, the meat of hogs which have died of swine erysipelas is not, in and of itself, injurious to health (page 689). These considerations are important only in court, but here their importance is great; for, in order to fulfil the condition of fact of Section 12 of the Food Law, it is not sufficient to demonstrate that the meat came from a dead animal, since the injurious character must be an objective property inherent in the meat.

It should be remembered, however, that the meat of animals which have died a natural death may, in consequence of its great blood content and the greater or less length of time during which

the viscera, especially the abdominal viscera, are left in the body, rapidly undergo decomposition after death, often within 24 hours. Decomposing meat, however, is dangerous to health (page 757). For the rest, the meat of animals which have died a natural death in consequence of disease is of such a highly unfit character for food that it loses absolutely the quality of human food material, for civilized races have an insuperable aversion toward eating carrion, quite aside from the pronounced abnormal character which the meat of the dead animals exhibits (dark-red color, rapid decomposition, etc.). It is only exceptionally that we find among us people who buy and eat the meat of animals which have died a natural death, with full knowledge of the facts. The gypsies have no such scruples. It is a well-known fact that gypsies even disinter and eat the carcasses of animals which have died a natural death or which, according to their expression, have been "slaughtered by God."

If an animal has died, not on account of disease, but on account of chemical or physical agencies, the judgment to be rendered will be different. Such cases occur in animals which have died as a result of poisoning, lightning, fracture of a cranial bone, or of the first cervical vertebra, puncturing wounds of the heart, insufficiency of the cardiac valves, cardiac paralysis on account of the presence of echinococci in the myocardium and air emboli in cases of operations, suffocation as a result of strangulation or tympanites, and internal hemorrhages in consequence of rupture of the spleen and liver from trauma, etc.

The meat of these animals, except in cases of death from rupture of the spleen and liver, possesses its full content of blood and its appearance is thereby altered. It has poor keeping qualities. For the rest, however, it comes from animals which are in perfect health before death. No objection can be raised against the admission of such meat to the market as an inferior food material, provided the viscera are removed immediately after death and the features which stamp the animal as carrion are thereby eliminated.

XIV.

POST-MORTEM ALTERATIONS IN MEAT.

From the moment of slaughter to the time of its preparation for the table, meat may undergo a great variety of alterations.

Contamination During Slaughter.—Meat may become contaminated as a result of careless handling, or with bile or the intestinal contents during the act of slaughter. Moreover, it quite often happens that in excising abscesses the surrounding tissue becomes contaminated with pus.*

Acid Fermentation.—In another place, attention has been called to the fact that an acid fermentation regularly develops post mortem in the musculature and liver. With regard to the nature of this acid fermentation, we have the important results obtained by the investigation of W. Eber.

In the first place, he distinguishes normal, simple acid fermentation and abnormal, stinking acid fermentation. As is well known, simple acid fermentation occurs in meat at the time of the appearance of rigor mortis. According to Eber, the disappearance of rigor mortis is ushered in with processes which, according to the prevailing idea of the matter, are of an acid nature. Under the influence of this acid fermentation the meat acquires a peculiar agreeable flavor (ripening). Later (after three weeks or longer) traces of H_2S appear (hautgout). Ripening of the meat is observed in whole quarters or in other large pieces with a dry surface, since the process in question presupposes a large water con-

* Such contamination is to be avoided wherever possible. However, if it has occurred, the soiled layer of meat should be removed with a knife. In cases where the meat is contaminated with the contents of the intestines or abscess, washing is not sufficient to restore its normal character, since the bacteria which have found their way to the meat are not thereby removed, but, on the other hand, find their favorable conditions for multiplication on the artificially moistened meat.

tent and exclusion of the air. In small, superficially moist pieces of meat, decomposition sets in after a short time.

Acid Fermentation in Game.—Decomposition processes in the meat of game run exactly the same course as in the meat of domestic food animals. Acid fermentation in the meat of wild game is favored by the fact that this meat, in spite of its high blood content, decomposes much more slowly than the meat of domestic food animals. In this respect the horse stands next to wild game. Moreover, the meat of young animals resists the process of decomposition longer than that of older animals. As a rule, it is only on the surface and after a long transportation by rail and under high temperatures that we observe typical superficial decomposition, which does not penetrate deeply, and, according to Eber, may be completely removed by washing with water containing acetic acid.

Acid fermentation may be studied under especially favorable conditions in the liver. When just exenterated, the liver has an alkaline reaction. After twenty-four hours, however, when preserved in the usual manner, the reaction is slightly acid. After two to three days, small decidedly acid foci of an Isabel-yellow color appear in the parenchyma. The foci increase in size and after from eight to fourteen days the dark brown liver is altered so as to appear of an Isabel-yellow color. Eber emphasizes the fact that acid livers are neither injurious nor spoiled in the sense of the food law, and that they are nothing more than ripened livers.

The acid fermentation denominated by Eber as stinking, differs essentially from that just described. This is observed in the meat of game which has been stored while in a warm condition or which has been "heated." In such cases the hair is readily detached, the subcutis shows a green color, the musculature is copper-red, while its cut surfaces are grayish or dark-green. The odor of freshly cut surfaces is peculiarly disagreeable, resembling that of decomposition, and is accentuated by the addition of acid. The reaction is acid. Ammonia is absent. On the other hand, H_2S may be demonstrated in large quantities. According to Eber, "heated" wild game is to be considered as unsuitable for food in the most general sense on account of its pronounced variation from the normal. It appears, however, not to possess dangerous properties (Peters).

In addition to wild game, stinking acid fermentation occurs in slaughtered domesticated animals when the meat, while still warm, is stored in large pieces and in closed receptacles, or, in general,

when it is subjected to conditions under which it can not cool. This alteration is characterized by the term "suffocated."

ABSORPTION OF ODORS.—When improperly handled, meat may undergo post mortem alterations in its odor. Attention has already been called to the fact that not only living animal bodies, but also warm and cold tissues, possess the power of absorbing and retaining odors. We have numerous unexceptionable proofs of this fact. It is well known that meat absorbs the combustion products of tobacco smoke. Moreover, Dinter reported that the meat of a hog which had been carried for several days in a freshly-cleaned car, disinfected with carbolic acid, developed a highly disagreeable odor when boiled or roasted. In the year 1889, the meat of eight hogs was returned to a dealer in Berlin for the reason that it possessed a pronounced flavor of chlorin. The meat had hung near rooms which had recently been painted with a 10 per cent. solution of milk of chlorid of lime. Such cases have since been observed in large numbers.* They serve as an urgent warning against transporting animals in odorous cars, and against the utilization of odorous disinfectants in abattoirs. Moreover, the observations mentioned above show that in the construction of cold storage plants all odorous materials must be rigidly excluded.

ADMIXTURE OF HARMFUL METALS.—Furthermore, during the preparation and preservation of meat, it may absorb injurious metals. Thus, Masse reports a case of poisoning as a result of eating meat which was roasted on a spit over coals of dry wood which had been painted with white lead. Cases of chronic lead poisoning attributable to pieces of lead which had been loosened from improperly constructed mincing machines have been reported also from England. Finally, Ungar and Bodländer demonstrated that when conserves are packed in cans, there is always danger of the absorption of enough tin to be dangerous to health.

CONTAMINATION FROM INSECTS.—The occurrence of dipterous larvæ on meat in cases where it is carelessly handled during summer, and the occurrence of meal mites in hams may be mentioned incidentally. Sticker has called attention to the occurrence of the latter. According to Schmitz and Janssen, this is explained by the

*Israelitic dealers usually place leeks in the abdominal cavity of exenterated fowls for the purpose of making the meat keep longer. The meat thereby acquires the pronounced odor of leek.

fact that in certain regions, such as on the lower Rhine, it is customary to preserve hams in meal or bran.

Does the presence of dipterous larvæ on meat indicate long standing decomposition? To this question, which is frequently proposed to meat inspectors for consideration, the following answer may be made: Among the flies, the larvæ of which develop in animal materials, the house fly (*Musca domestica*), the blow fly (*M. vomitoria*) and the flesh fly (*Sarcophaga carnaria*) may be mentioned. The first two mentioned flies deposit their eggs in fresh and decomposing materials of animal origin and the larvæ hatch within twenty-four hours, while the flesh fly deposits living larvæ in decomposing material. It, therefore, appears that the mere demonstration of dipterous larvæ is no proof that the material has been long in the process of decomposition. The length of the larvæ, which on the first day is 1 mm. and within ten days reaches 10 mm., may give an approximate indication of the length of the period of decomposition.

Localization of Micro-organisms.—By far the most important post mortem alterations are produced by the localization of micro-organisms on meat. As a result of its peculiar chemical composition, meat furnishes an unusually favorable medium for fungi of all kinds. As mentioned on page 198, Bocklart reported that about thirty of the species of bacteria which he tested commonly develop luxuriantly in meat broth.* The localization of fungi on meat is most likely to occur in cases where it possesses a high moisture content as a result of improper preservation.

Among the alterations of the last named sort belong moldiness of the surface of meat, as well as red and blue coloration due to the localization of *Bacillus prodigiosus* and *B. cyanogenes*. These alterations, however, for practical purposes, are of slight importance, since they usually cause no injury to health, in and of themselves,† and since the growths in question take place simply on the surface

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* Since the pathogenic organisms of human infectious diseases also thrive well on meat, it is necessary to take the precaution that persons who are suffering from infectious diseases (typhoid, cholera, scarlet fever, infectious skin eruptions, etc.), or who have even completely recovered from such diseases, are prevented from coming in contact with meat.

† In contrast with the red colored meat of food animals, red colored sardines have been demonstrated to be injurious. Loir is of the opinion that the red coloration of sardines is caused by a toxic variety of *B. prodigiosus* which settles upon the sardines in large quantities before the latter are preserved in boiling oil

and may easily be removed by cutting away the superficial layers of meat.

The localization of photogenic bacteria on meat is of more importance, and the decomposition of meat by putrefactive bacteria is of quite especial importance. These two alterations require, therefore, a more detailed discussion.

Gray Coloration of Sausages.—In sausages intended for long keeping a gray coloration frequently appears on the peripheral portions, without the slightest change in odor or taste of the other parts of the sausage. The cause of this striking phenomenon is not understood. Falk and Oppermann suspected that *Bacillus mesentericus*, which had been noted by Serafini as a regular occurrence on sausages, was the cause of the alteration in the color of these sausages. Meyer attributes the gray coloration of sausages to a loss of salt as a result of endosmotic processes. He found as much as 3 per cent. less salt in the periphery of gray sausages than in the interior, while in red sausages the difference amounted to only 1 per cent. According to Glage, volatile sulphur compounds are concerned in the gray coloration of sausages (sulphuretted hydrogen and mercaptan). These are given off, as shown by Glage, not only from fresh but also from conserved meat, and the sulphuretted hydrogen may change the red coloring material of the muscle in sausages to a gray color. The "latent green colorations" (Glage) in poorly salted hams and pieces of pickled meat, and which appear only after exposure to oxygen, are to be attributed to the action of sulphuretted hydrogen.

Decomposition of Fat.—In addition to moldiness and alteration as a result of chromogenic bacteria, fat exhibits a specific alteration (rancidity). Formerly this alteration was ascribed to the appearance of free fatty acids and the degree of rancidity was estimated according to the percentage of fatty acids present. Scala, however, found, as a cause of the rancidity, an aldehyde, the presence of which may be demonstrated by collecting the distillate obtained by means of steam in a hydrochloric metaphenylen-diamin solution. The degree of rancidity may be determined colorimetrically by the yellow coloration of the reagent.

1.—Phosphorescent Meat.

Record of Cases.—The literature contains a large number of observations concerning meat which possessed the striking property

of emitting light. Fabricius ab Aquapendente, in the year 1592, reported that in Rome a portion of a slaughtered lamb which had been preserved in the raw state, became phosphorescent. In the year 1780, according to another report of a meat dealer in Orleans, the whole meat supply became phosphorescent. The physiologist, E. von Brücke, reported that in Vienna at the beginning of the 50's, a large number of sausages were observed in a phosporescent state. Nuesch in Basel in 1877 observed that pork which was kept in a receptacle in a pantry emitted a green light of such intensity that people were able to recognize each other by it and to read the time on their watches. Recently many reports have been published concerning similar cases. Phosphorescence in meat in cold storage plants of certain public abattoirs has proved to be a great calamity.

From the reported cases the following may be mentioned: Two women purchased a pound each of pork and beef and preserved it in a damp room. When examined by daylight, both kinds of meat presented "unobjectionable, fine appearing, fresh and perfectly wholesome" products. When examined in the dark, it appeared that the pieces of cervical vertebræ in the pork and the surrounding tissue emitted as bright a light as white-hot iron. The paper on which the meat had lain remained phosphorescent for some time, ten to fifteen minutes (Gotteswinter).

Beef sausages were kept in a porcelain dish in an unused oven with an open door and after a period of four days showed a pronounced phosphorescence. They shone brightly in a dark room and a number of intensive, bluish-white, shining, pearl-like foci were observed in them. The sausages were still quite fresh, smelled like fresh meat, and were eaten in large quantities without any ill effects, by the butcher who gladly took them back in order to prevent any legal proceedings.

Etiology.—In 1877, Nuesch demonstrated phosphorescent bacteria in phosphorescent meat. Similar organisms were found by Pflüger in fish meat, the phosphorescent property of which has long been known. In 1879, Baucel and Husson demonstrated that the phosphorescence of lobster meat is always to be attributed to the action of bacteria. It is well known that the phosphorescence of the sea is caused by bacteria.

The following species of phosphorescent bacteria occur in sea water: *Photobacterium pfluegeri* and *P. phosphorescens* (on salt-water fish in general), *Photobacterium fischeri* and *P. balticum* (Baltic Sea). Finally, *P. indicum*, in the West Indian Ocean (Carribean Sea) and

P. luminosum (North Sea). F. Ludwig demonstrated that *P. pfluegeri*, which, according to him, caused the phosphorescence of the meat of haddock, may be transmitted to beef, pork and veal. In the case which was reported by Nuesch, infection of the meat took place from the rotten timber in the ceiling of the pantry which undoubtedly was the source of phosphorescent bacteria. Phosphorescence disappears with the appearance of decomposition.

For destroying the phosphorescence, it is recommended that infected substances and the rooms be treated with acetic or salicylic acid.

JUDGMENT.—Phosphorescent meat is not dangerous to human health. On account of its objective variation from the normal condition, it is a spoiled (inferior) food material.

2.—Decomposing Meat.

GENERAL REMARKS.—The bacteria of decomposition thrive on meat, perhaps the best of all bacteria. If care is exercised in the treatment of meat (allowing it to cool in well-ventilated rooms and preserving it in cold storage), we are in a position to check the development of putrefactive bacteria, which are present everywhere, and to maintain the meat in a fresh and unaltered condition for a certain length of time. With careless treatment, on the other hand, especially if freshly slaughtered pieces of meat are heaped together while still warm and if they are placed in poorly ventilated rooms with a high temperature, the meat under such "hygienic mistreatment" becomes simply a nutrient medium for putrefactive bacteria.

It should be observed that the harmful effects of improper preservation are not confined to fresh meat alone, but also to cooked and roasted meat. As emphasized by Schmidt-Mülheim, the common practice of heaping up hot sausages and pieces of roast beef in layers in closed receptacles for use in festivities, must, from a bacteriological standpoint, be considered as a very dangerous method of preserving meat.

The property of meat as a specially favorable medium for the development of decomposition plays a large national economic and hygienic rôle. Von Hofmann, in Leipsic, estimates the loss of perishable food material as a result of improper care at 10 per cent. Moreover, the cases of so-called sausage poisoning, the numerous cases of sickness after eating decomposed ham, "high"

game, poorly preserved pieces of meat, and recently the mysterious cases of mince meat poisoning, furnish abundant evidence of the danger from eating decomposing meat.

Putrefactive Bacteria.—The number of bacteria which are concerned in the putrefaction of proteids is very large. The most important species, however, is *Proteus vulgaris* (Hauser). In addition to numerous species of bacteria which liquefy gelatin, Kraus found in decomposing meat, five non-liquefying species, one of which possessed great similarity to Gärtner's *Bacillus enteritidis* and was distinguished from the others by the fact that it killed mice in combination with the putrefactive bacteria which liquefy gelatin. Serafini demonstrated *B. mesentericus* of Fluegge in addition to other species of bacteria in all sausages. This species, as is well known, is not pathogenic, but induces decomposition in sausages.

Fig. 248.

Proteus vulgaris from an agar culture 24 hours old. × 500 diameters.

From meat which had caused bloody vomit, bloody diarrhea, great depression, and some fever in 10 persons with a fatal outcome in one case, Levy isolated *Proteus vulgaris*. This species was found also in the incrustation of filth in the ice chest in which the meat had been kept.

Hamburger and Wolff examined meat which had caused summer cholera in the inmates of the mansion of the Utrecht Deaconess. A non-motile organism was isolated from the meat, which was 1 to 1.5 μ long and 0.4 μ broad. The species was easily stained, even by the Gram method. On bouillon cultures, a thin pellicle was formed with vertical bands and a brush-like growth was produced on gelatin. The bacteria grow rapidly on meat and develop a pronounced odor of ammonia. Raw or boiled infected meat and meat broth made from it are pathogenic for dogs and mice (diarrhea). On account of the formation of granules on the pellicle of meat broth cultures, Hamburger and Wolff named the organism *Bacillus cellulœformans*. These authors consider it probable that the species is a putrefactive organism.

The Process of Putrefaction in Meat from Different Sources.—Under normal conditions—that is, in slaughtering live

animals—putrefactfon begins after a certain period in the parts of the meat which are accessible to the air and gradually penetrates into the interior along the course of loose strands of connective tissue (compare page 740). In the meat of animals which are affected with febrile conditions, especially those of a septic character, putrefaction appears more promptly and penetrates into the deeper parts more quickly. In dead animals which are allowed to lie without exenteration, superficial and deep-lying putrefaction appears simultaneously and after a very short period, partly in consequence of the full blood content of the meat and partly in consequence of the penetration of the putrefactive bacteria from the intestines into the neighboring venous trunks. In the meat of animals which have died a natural death, the deep-lying putrefaction is characterized by the formation of gas, for the reason that not only aërobic, but also anaërobic, gas-forming, cadaver bacilli penetrate into the blood of cadavers. In deer which are not immediately dressed, hunters at least open the abdominal cavity in order to air the carcass, an empirical measure which is based on the fact that the carcass cools off more rapidly after the admission of air into the body cavity and the migration of anaërobic bacteria from the intestine into the neighboring musculature is prevented. In small game, such as hare and birds, the alimentary canal may remain in the abdominal cavity without producing the above mentioned harmful results. This is explained by the rapid cooling of small animal bodies, which prevents the growth of cadaveric bacteria.

Partial Decomposition.—Up to the time of the introduction of meat inspection in Norway, the bad habit prevailed of allowing fasting calves to lie unexenterated after slaughter until the abdominal muscles and kidneys acquired a stinking, discolored character. This practice frequently led to cases of illness after eating the meat. Thus, Nielsen reports that the foreparts of a calf treated in this manner were eaten without bad consequences, while the consumption of the loins and abdominal musculature, or those parts which were in immediate contact with the alimentary tract, caused serious cases of illness, whether eaten in a boiled or roasted condition.

Influence of Air Upon the Decomposition of Meat.—Nielsen attempted to determine whether and under what conditions during the decomposition of animal proteids poisonous decomposition products of the group of albumoses, soluble in water, are formed.

During this investigation he found that when a limited amount of air was admitted, albumoses exhibiting toxic action when injected subcutaneously, did not appear on the fifth, tenth or fifteenth day.

When the air was freely admitted, however, albumoses with pronounced poisonous properties developed in meat which was only five days old.

Decomposition Toxins.—In the decomposition of proteids, poisonous substances develop (decomposition toxins), which have already been discussed under "Putrid Intoxication" (page 553).

Isolation of Decomposition Toxins from Decomposing Meat.—For isolating decomposition toxins from decomposing meat, Scholl recommended pressing out the fluid and the extraction of the material thus obtained with pure water at a temperature of 40° C. for a period of twenty minutes. Scholl emphasizes the fact that according to this method it is an easy matter to demonstrate toxins even in small quantities of decomposing meat. From one piece of beef of the size of an ordinary steak which had been putrefying for two days, it was possible to extract so much toxin at a temperature of 40° C. that a guinea pig was paralyzed within two hours after receiving an injection into the body cavity. Jeserich and Niemann found that the toxins which arise during the decomposition of meat persist in the meat for a short time in a very virulent condition, but soon disappear on account of further decomposition. For this reason it is recommended that decomposing material which is to be investigated should be laid immediately in absolute alcohol, since in this material the toxin remains unaltered for a long period. For further testing the alcoholic extract, it is evaporated and the material left behind is dissolved in water. Subcutaneous injections of small quantities (one to two cc.) of the aqueous solution kill guinea pigs and rabbits if virulent decomposition products are present.

Demonstration of Decomposition.—In addition to the above named toxic elements, substances are produced under the influence of decomposition bacteria, viz., aromatic substances and fatty acids, mercaptan, ammonia and carbolic acid. The methods for the positive demonstration of decomposition depend upon the presence of ammonia. These methods are of great value, since our olfactory organs may often fail us in the investigation of odorous or stinking materials, and since alterations of color (modification into a dirty gray or green) as well as of consistency are not always conspicuously

present. According to W. Eber, the odor is also unreliable, since, quite aside from individual differences in the perception of odors, it is not a simple test. Decomposing meat smells differently than decomposing crabs. Moreover, fish emit a peculiar variable odor, and, finally, decomposing oysters are widely different in their odorous products from decomposing green herring or from the odor of a carcass which has been dead for several days. The differences in the odors of decomposition arise also from their different behavior toward acids and alkalies. Some are not affected by the addition of acids or alkalies, while others are intensified. Moreover, some contain mercaptan and others not. Strange to say, mercaptan is entirely wanting in the intensely odorous products of superficial decomposition of meat. Finally, in the decomposition of schlackwurst and salt meat, the disagreeable odor may not appear in the raw material, but is first observed after cooking.

Schmidt-Mülheim called attention to the alkaline reaction of decomposing meat due to the formation of ammonia. Decomposition can not be hastened, however, by alkalinity alone, since in addition to fresh organs, blood also and lymph extravasations, as well as pickled meat and smoked hams, may possess an alkaline reaction. Moreover, the reaction in decomposing materials varies. An acid reaction (mixed processes), an amphoteric (brine and juicy materials) or an alkaline reaction may prevail. The latter is the usual one, at least in the decomposition of meat.

W. Eber, accordingly, proposed an objective method of investigation which is based on the demonstration of free ammonia, the so-called ammonia test, and which gave good results in Eber's hands, in investigating decomposing meat and fish.

Method of Making the Sal-Ammoniac Test.—Reagent: One part pure hydrochloric acid, three parts alcohol and one part of ether, mixed together and preserved in a closed vessel.

A test tube 2 cc. in diameter, 10 cc. in length, receives enough of the reagent to cover the bottom of the glass to a depth of about 1 cm. It is then corked and shaken once. A sample of the material to be examined is then rubbed with a clean glass rod, or, if its consistency is still quite firm, a part of the material the size of a pea is fixed to the rod by adhesion. The rod thus prepared is quickly dipped into the glass filled with the fumes of hydrochloric acid, alcohol and ether, so that its lower end sinks to a depth of 1 cm. beneath the surface of the fluid and so that it does not touch the walls of the vessel.

For practical purposes in making the test, a cylindrical vessel furnished with a perforated cork holding a glass tube may be used in the place of the test tube. If ammonia is present, a cloudiness appears after a few seconds, which sinks down at the end of the glass rod or surrounds it. This reaction increases in intensity with the degree of putrefaction. After a short time the fumes may fill the whole vessel and may be temporarily precipitated as a white layer on the walls.

The sample should not be colder than the test tube (condensation of the fumes of the reagent). Moreover, the test for decomposition should not be made in rooms which contain free ammonia.

The decomposition test of Eber can not be considered as proving unquestionably the presence of decomposition, for the reason that the test may give a positive result in undecomposed meat (for example, mutton), and especially in meat under brine (pickled meat, pickled herring, sardines, etc.), on account of the frequent normal occurrence of trimethylamine. In the presence of other phenomena of decomposition, however, it serves to confirm the diagnosis.

In demonstrating decomposition in larger pieces of meat, attention should be called to the fact that a superficial examination is not sufficient, but that deep incisions must be made into the meat.

Demonstration of Decomposition in Canned Meat.—On account of the frequent occurrence of poisoning after the consumption of canned meat, the means of recognizing decomposition processes in canned meat are of great practical value. The French Army consumes annually 3,000,000 cans of conserved meat, containing five rations each. In 1897, 201 cases of sickness, and in 1898, 198 cases appeared, one of which ran a fatal course (Vaillard). During the Spanish-American war, extensive outbreaks of sickness appeared in the American army after eating canned meat. The pathological symptoms consisted either of non-febrile digestive disturbances, or of febrile gastro-enteritis. According to Ballard, the ends of the cans in case of well conserved meat should be depressed on account of the condensation of the steam after the can is soldered. In case of poorly cooked conserves which are subsequently affected with decomposition, the cover of the cans is distended outward as a result of the gases of decomposition. Unscrupulous manufacturers frequently boil such swelled cans a second time. In order to do this, however, a second opening must be made in the can, which hole is later soldered. Accordingly, a

preventive measure may be adopted against possible poisoning from decomposed canned meat, requiring the exclusion from the market of swelled as well as twice-soldered cans. After opening suspected cans, one finds that the gelatin surrounding the meat is discolored and liquefied (compare page 760). If poisonous substances were present in the meat at the time of its preparation, the recognition of injurious canned meat by the above mentioned process is impossible.

JUDGMENT.—According to the experimental investigations discussed on page 552, decomposing meat must be considered a poisonous food material. As shown by experience, it has in many cases caused injury to health and even the death of man. If, on the other hand, it is asserted that decomposing meat, known euphemistically as hautgout, is a delicacy for gourmands and often eaten without injurious consequences, this fact is of no importance in sanitary police work; for the positive fact that decomposing meat is calculated to injure human health is, despite the numerous observations of its harmless effects, a quite sufficient basis for the exclusion of all decomposing meat from the market.* Attention has rightly been called to the fact that admirers of hautgout should be permitted to allow the meat to ripen *privatim* before eating, but that it is the duty of the authorities to exclude decomposing meat from the market as a dangerous food material. Finally, the fact should be emphasized that decomposition toxins are not destroyed by ordinary cooking.†

Van Ermengem, to whom we owe the brilliant investigations of the etiology of meat poisoning and botulism, is of the opinion that decomposition is of but slight importance in the etiology of cases of sickness after eating meat. As proof of this position he calls attention to the fact that, according to Navarre, decomposing fish serve as a delicacy for 300,000,000 Indians, Indo-Chinese, Malays, Polynesians and negroes of all kinds. Forster, however, calls attention to the fact that among these people decomposing fish, like the pungent cheese of the European table, are used as a

* If we have to do merely with a slight superficial decomposition, such as occurs frequently in wild game, the meat may be easily put in marketable condition by cutting off the superficial layer, or, according to W. Eber, by washing in acetic acid.

† Scholl found that the poisonous property of decomposition toxins was not completely destroyed until after subjection to a temperature of 106° C. for a period of 1½ hours.

condimental addition to rice, and that we know nothing of the decomposition processes which take place in this and similar food materials, as, for example, the fermented eggs of the Chinese.

APPENDIX.

1.—Sausage Poisoning (Botulism, Allantiasis).

Historical.—The earliest reports concerning so-called sausage poisoning are contained in the work of the Schwabian poet and physician, Justinus Kerner. According to Senkpiehl, who made a careful compilation of the literature concerning botulism up to the year 1877, Kerner's "Neue Beobachtungen über die in Württemburg so häufig vorfallenden tödlichen Vergiftungen durch den Genuss geräucherter Würste," Tübingen, 1820, and his other treatise, "Das Fettgift oder die Fettsäure und deren Wirkung auf den tierischen Organismus," Tübingen, 1822, appear to contain the first published reports concerning this matter.

Kerner described as the first case one which occurred in Kleinenzheim, in 1793, and made reference also to an epidemic in Moosberg, Breitenberg, Reichenbach, Stammheim and Sulzer Oberamt, a total of 76 cases with 37 deaths. In the second treatise, the author enumerated 98 other cases with 34 deaths. In two instances epidemics appeared, during which 13 persons became ill and 6 died after eating sour black pudding, while 15 cases with 5 deaths occurred after eating decomposed sausage of other kinds.

Shortly after this work of Kerner (1824), Weiss reported 29 cases of sickness with 3 deaths after eating spoiled sausage in the town of Murrhardt. Numerous cases of sickness from eating bad sausage were reported during the 50's by the Würtemburg physicians Bach, Faber, Schütz, Berg and Reuss. Later Müller prepared an account of 62 cases in the Würtemburg Korrespondenzblatt in 1863. In the same journal, which may be considered as a veritable treasury of literature concerning sausage poisoning, Josenhaus and Baumann (1869) reported two epidemics as a result of eating hirnleberwurst and ordinary leberwurst which was six weeks old. In the same journal, Hedinger noted the poisoning of several persons by leberwurst, and Nauwerck reported an outbreak of sickness among 10 persons in Gamertingen after eating schwartenmagen. The last cases of sausage poisoning in Würtemburg occurred in Reutlingen, Horb and

Nordstetten. In Reutlingen, 20 persons were affected with botulism after eating leberwurst, while 100 persons were similarly affected in Horb and Nordstetten.

Occurrence.—In comparison with Würtemburg, other countries show a surprisingly small number of cases; especially in northern Germany, the occurrence of sausage poisoning is comparatively rare, while from Bavaria and Baden, several, but not nearly so many cases as from Würtemburg, have been reported. However, that the disease formerly occurred in northern Germany is shown by two publications of the Royal Imperial Government at Arnsberg, of January 18, 1822, and December 16, 1825, in which a warning is issued against poisoning as a result of eating semi-fluid, sour and malodorous sausage.

If we ask why botulism occurs so frequently and causes so many deaths in Würtemburg, an explanation is to be found, in the first place, in the great development of sausage manufacture and in the consumption of sausages in Würtemburg, and, also, in the ignorance previously exhibited in preparing certain kinds of sausage, as leberwurst and blutwurst, for consumption at a considerably later date. I emphasize the word "previously," for the gradually diminishing number of cases of sausage poisoning in the last decades proves that a change has taken place in this regard. In northern Germany, on the other side of the Main, it is the custom to eat sausages prepared from the viscera, as, for example, leberwurst and lungenwurst, only in a fresh condition. At any rate, smoked leberwurst in northern Germany is exceedingly rare, except in Thüringen. The so-called long keeping sausages of northern Germany (mettwurst and schlackwurst), which are the only kinds which are preserved for the period of months or one year, consist of musculature, which, when properly conserved, resists decomposition much longer than lungs, liver or blood. In the etiology of sausage poisoning in Würtemburg, however, smoked visceral sausages (leberwurst, hirnleberwurst, schwartenmagen, presssack and blunzen) play an important rôle. These sausages are poorly adapted to keeping for a long time, since they contain material which spoils readily. Moreover, the customary method of interrupting the smoking, in which the fire is not maintained during the night, is in part the cause of the poor conservation of sausages in Wurtemburg. Finally, in many cases, especially in cases of poisoning by means of large sausages like blunzen and presssack, the cooking and associated destruction of the putrefactive bacteria were probably

incomplete in consequence of a lack of knowledge of the extremely slow penetration of heat into meat and meat products.

An illness apparently identical with poisoning by decomposed sausage has been frequently observed after eating meat prepared by other methods. Thus, after eating decomposing meat and the broth obtained from it, or boiled, warmed up, or re-roasted meat; also after eating meat from a can of conserves which had been opened for eight days; after eating pickled products from poorly preserved calf liver; freshly boiled pork which had been kept in an oven; after eating imperfectly cooked teal; a rabbit pie preserved for three months under fat; after eating a partridge which was found dead; after eating the sauce of roast mutton left over from the previous day; after eating pickled meat which had fermented in a cask; after eating spoiled smoked goose and mutilated, bloody parts of game.

Cases of poisoning are especially frequent after eating decomposing ham. In this connection, attention should be called to the fact that frequently it is not the whole ham, but only the superficial parts and the parts which lie next to the bones, which are injurious.

Moreover, Wiedener made a report of an epidemic of illness after eating roast goose. Among the 180 persons affected, about one-half exhibited symptoms of convulsive pain, vomition and diarrhea. The geese, thirty in number, had been left hanging unexenterated in the cellar for one day. Bouchereau and Noir reported an outbreak of poisoning in which ten soldiers were affected after eating canned meat. The meat had no disagreeable odor or smell. The gruel-like mass, however, in the cans was of a brownish color and was liquefied.

Etiology.—With regard to the etiology of botulism, the opinion formerly prevailed that this disease was caused by the products of ordinary proteid decomposition. This assumption was disproved by the epoch-making investigation of the Belgian scientist, Van Ermengem, who has earned great credit for his studies on the etiological explanation of the diseases which appear after eating meat.

Van Ermengem investigated portions of a ham which had caused slight or acute symptoms of botulism in ten persons in December, 1895, in the village of Elezelles. Three of the patients died. The part of the ham which remained was examined by him and proved not to be decomposed, but had a musty, rancid odor. The ham was pale in color and more readily discerptible than

ordinary ham. Furthermore, according to the statements of all the consumers, it possessed a bad taste. Experiments were instituted with the poisonous material and these experiments overthrew the assumption of Housemann that the theory of sausage poisoning could not be subjected to an experimental test. Van Ermengem found that cats were well adapted for experimental investigations in this field; that phenomena appeared in them which paralleled the pathognomonic symptoms of botulism, viz., mydriasis and paresis. As second in value for this purpose, mention is made of pigeons, which, in addition to paresis of the nerves, exhibit other interesting paralytic phenomena, viz., ptosis and inequality of the pupils. Rabbits, guinea pigs and apes are also very susceptible. These animals may be easily poisoned per os and show a pronounced paretic disturbance. From the toxic ham and the spleen of one of the dead pigeons, Van Ermengem succeeded in cultivating anaërobic bacteria which possessed the power of producing a very active toxin. This toxin induced in the experimental animals all the symptoms of botulism. It is thus demonstrated that the *Bacillus botulinus* discovered by Van Ermengem is one or the only cause of botulism.

Bacteriology.—*Bacillus botulinus* is 4 to 9 μ long and 0.9 to 1.2 μ thick. It is a straight rod with somewhat rounded ends and slightly resembles the edema bacillus. The rods are usually isolated. Occasionally, however, they are found in pairs or short threads. *B. botulinus* is an obligate anaërobe and forms oval spores in the end of the rod, more rarely in the middle, which are somewhat thicker than the rods themselves. Sporulation occurs only under a temperature of 35° C. and takes place more vigorously in strongly alkaline media containing two per cent. grape sugar. The organism is slightly motile, possesses 4 to 8 flagella. Cultures of *B. botulinus* develop no odor of decomposition, but rather a penetrating odor resembling butyric acid. Furthermore, it forms an extraordinarily poisonous toxin (toxigenic bacillus). In order to insure a luxuriant and toxic growth, a certain degree of alkalinity is required (10 to 15 cc. of a one-tenth normal soda solution per 100 cc. of the medium). The optimum temperature lies between 20° and 30° C. The cultures require especial care. In fluid media the bacillus grows only in vacuo, or in the presence of an inert gas. Growth is hindered by CO_2. The addition of 2 per cent. grape sugar makes possible a luxuriant growth in gelatin agar. An excellent medium is furnished by means of boiled pork

rendered alkaline and with the addition of grape sugar (1 per cent.), peptone (1 per cent.), salt (1 per cent.) and gelatin (2 per cent.). In this medium the *Bacillus botulinus* grows without special care with regard to the exclusion of the air, provided melted lard is poured over the meat while cooking.

It is a very remarkable fact that the growth of *B. botulinus* ceases in pork when the latter contains 6 per cent. of common salt. Now, pickling is usually done in at least a ten-per-cent. solution of brine; therefore, ordinary pickling is sufficient to check the development of *B. botulinus* in meat. Furthermore, the bacillus, even in the spore-bearing condition, is sterilized with certainty by subjection to a temperature of 80° C. for one-half hour. The toxin of botulism is rendered inactive by heating to a temperature of 70° C. for a period of one hour. Boiling is, therefore, a good prophylactic against botulism. The toxin of botulism is only slightly resistant to heat, light and alkalies. Finally, it is an important fact that the disturbances caused by eating meat appear to be due exclusively to the toxin preformed in the meat, since an increase in quantity or further production of the poison in the body of experimental animals can not be demonstrated. *B. botulinus* appears not to be widely distributed in nature. Brieger and Kempner have isolated the pure toxin from cultures of *B. botulinus*. Rabbits are killed within 24 hours by 0.0005 mg. of this toxin. Furthermore, Kempner, in coöperation with Pollak, succeeded in preparing an active therapeutic serum against sausage poisoning by treating animals with the toxin of botulism.

FIG. 249.

Bacillus botulinus from a sugar-agar culture. Some of the bacilli already possess spores. × 500 diam.

Finally, it should be observed that these authors did not succeed in isolating a toxin similar to that of botulism from the products of decomposition.

PATHOLOGICAL SYMPTOMS.—The clinical symptoms of sausage poisoning are of a very peculiar nature. In the first place, it should be noted that the pathological picture is by no means uniform. Variations appear, especially with regard to the incubation period and duration of the disease. These variations may be explained by the larger or smaller content of botulism toxins in the

meat. In some patients, the most virulent symptoms of intoxication appear immediately after eating the sausage or meat, while in other patients these symptoms appear later. In some cases the effects of the disease continue for 1, 2 or 3 days, and then disappear entirely, while in other cases convalescence is very slow and is extended over a period of several weeks. However, all cases of sausage poisoning uniformly exhibit the following symptoms: indisposition, bodily pains, pronounced weakness, vomiting, constipation, or, more rarely, diarrhea. The last-named symptom does not appear until the second or third day. Optical disturbances are pathognomonic. The eyes are affected in nearly all cases. One observes paralysis of the optic nerve (mydriasis), of the motor oculi (ptosis, disturbances in accommodation and strabismus), also paralysis of the trochlear and abducens. The lachrymal nerve is occasionally affected through the trigemini. According to Van Ermengem, botulism is characterized as follows:

1. By an increased or decreased secretion of the saliva and mucus of the mouth, pharynx, etc.

2. By a more or less marked external or internal ophthalmoplegia (blepharoptosis, mydriasis, paralysis of the accommodation center, diplopia, internal strabismus).

3. Dysphagia, or aphagia, aphony, persistent constipation, retention of urine.

4. Absence of fever and of sensory and cerebral disturbances.

5. With these symptoms respiratory and cardiac disturbances are often associated which may cause death more or less suddenly with symptoms of bulbar paralysis.

6. Finally, the characteristic symptoms (mydriasis, ptosis) appear, at the earliest, 12 to 24 hours after eating the suspected food material. They are often ushered in with temporary gastro-intestinal symptoms. These develop gradually and do not disappear until after several weeks.

With regard to the pathological anatomy, mention should be made of a negative post-mortem finding. Hyperemia of most of the viscera is observed. Under certain conditions symptoms of gastro-enteritis and fatty degeneration of the liver may be present.

Mortality.—The death rate in cases of sausage poisoning is very high. According to Müller's estimate, one-third of the patients die, and Senkpiehl, in essential agreement with Müller, found a death rate of 40 per cent., or 165 deaths among 412 patients (1789–1886).

Prophylaxis.—Cases of sausage poisoning are preventable by hygienic instruction of the public and by suitable laws. The public must be warned against eating any meat which is in process of decomposition or which is already decomposed. Warning should also be issued against eating strongly spiced sausages, for sausage which is carelessly prepared from decomposed meat is often strongly spiced by butchers in order to conceal its disagreeable taste. Moreover, suitable punishment should be provided for such dealing, in order to induce sausage makers to use fresh meat in the preparation of sausage, and thoroughly to clean the sausage casings with the aid of harmless disinfectants wherever possible, and also to induce them to cook sausages which are intended for immediate consumption and to smoke sausages which are intended for long keeping. As shown by Serafini, a water content of 30 to 35 per cent. furnishes the best security for the preservation of sausages, while the addition of saltpeter, boracic or salicylic acids excercises a noticeable effect.

Finally, the sanitary police should strongly insist that no sausages of any kind be prepared from cases of emergency slaughter; at any rate not from animals in which a thorough bleeding has not taken place. For experience teaches that the meat of such animals is abnormally susceptible to decomposition.

On the basis of his investigations, Van Ermengem has formulated the following principles in the prophylaxis of botulism:

1. Meat conserves which are subjected principally to anaërobic conditions, should not be eaten in a raw condition, but only after thorough cooking.

2. Conserves which arouse suspicion on account of their rancid odor are to be absolutely excluded from consumption.

3. With regard to hams, a sufficiently concentrated brine appears to prevent them from spoiling.

2.—Poisoning from Minced Meat.

Differences Between Minced Meat Poisoning and that Which Follows After Eating Decomposed Meat of Other Kinds.—Minced meat poisoning is essentially different from poisoning as the result of eating decomposed meat; for the former cases occur after eating raw meat in which decomposition processes are apparently absent. Furthermore, the consumption of such meat in a raw condition results in the development of a pronounced toxic effect, while in a roasted condition either no effect or only a slight illness takes place.

Occurrence.—Minced meat poisoning, like trichina epidemics, is closely associated with the habit of eating raw meat, which is widespread and firmly rooted in certain parts of Germany. Thus far, cases of minced meat poisoning have been observed only in the States of Saxony. In that region, raw sausages and raw minced meat appear to be real delicacies, the consumption of which has not been checked by the numerous epidemics which have occurred.

The nature of minced meat poisoning has not been sufficiently explained. Since these cases occur only under a high external temperature in spring and summer, it may be concluded that we have to deal with decomposition from the effects of bacteria which are destroyed by boiling and do not form toxins. Bacteria find a more favorable medium in minced meat, the more water has been added to the meat by underhand methods.

Record of Cases.—The following cases of minced meat poisoning have been reported: In Chemnitz in 1879, an outbreak of poisoning occurred after mettwurst and raw beef had been eaten, during which 241 persons were affected and 2 died. Seven years later in the same city, 160 persons became ill after eating minced meat. Similar epidemics as a result of eating raw minced meat have been observed during the last six years in Dresden (11 cases), Gerbstädt (more than 50 cases), and in Gera (30 cases).

Symptoms.—With regard to the symptoms in the second epidemic of minced meat poisoning in Chemnitz, Haupt, according to Schmidt-Mülheim, makes the following statements: The pathological symptoms varied according to the quantity of meat which was eaten and the age and constitution of the patients. The symptoms appeared four to twenty hours after eating the meat, and, in persons who had eaten only a small quantity of the meat, consisted of a slight indisposition, congestion of the head and weakness. However, in persons who had eaten larger quantities of meat, the symptoms included vomiting, dysenterial diarrhea, headache, dizziness and extreme depression. In children, the cases exhibited cholera-like symptoms, high fever, violent headache, delirium and alarming weakness. A few cases appeared to be critical after a number of days. All of the patients, however, recovered after a shorter or longer period of illness. In the case of a child under one year of age, it could not be determined whether death was a result of eating the meat or not.

Prophylaxis.—For preventing cases of minced meat poisoning, Schmidt-Mülheim recommended that the long preservation of raw meat during the warm days of summer be prohibited by police regulations. Such a regulation was subsequently passed in Schmalkalden.

Appendix.

(a) Poisoning from Decomposing Fish and Crustacea.

In the decomposition of fish and crustacea, toxins appear to be formed which greatly exceed in toxicity those formed from the meat of warm blooded animals. According to Bocklisch, the toxic properties of fish meat are greatest in the first stage of decomposition.*

For this reason, careful attention should be given by the market police to traffic with decomposing fish and crustacea.

Recognition of Decomposition in Fish.—In addition to the above mentioned character of decomposition (page 754), Gerlach mentions other special indications of decomposition in fish. He says, "dead fish are to be considered as unfit for food when the eyes have lost their sheen, or the cornea is somewhat cloudy, the red gills pale and the meat soft so as to pit on pressure with the finger, or, finally, when the scales are easily loosened."

In the later stages of decomposition in fish, the entrails are partly forced out of the body cavity as a result of the decomposition gases. Baranski recommends laying fish in water in testing their condition. Dead fish which sink are good and undecomposed, while putrefying fish float upon the water.

With regard to the cadaverous decomposition of crustacea, the Berlin police president called attention in a public circular to the fact that in boiled crawfish, shrimps and other crustacea, injurious substances may develop after long standing, even before the appearance of the odor of decomposition and when the animals have been boiled after being allowed to die. In such crawfish, the telson is usually not curved under the abdomen.†

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* From the similar pathological symptoms in man, Van Ermengem concludes that the most frequent form of ichthysm is almost identical with sausage poisoning and therefore has the same etiology as the latter.

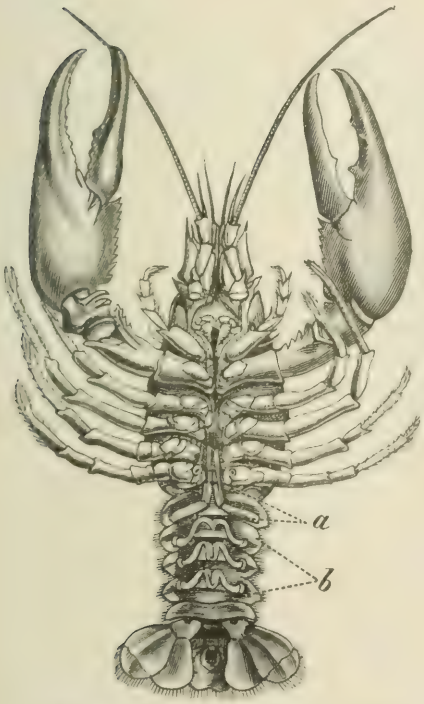
† Landgericht I. in Berlin decided with regard to dead crawfish that such material must be considered as highly unfit for human food and must, there-

(b) Poisoning from Clams.

The outbreaks of clam poisoning which were observed in Wilhelmshaven in 1885 and 1887 and which are described by Schmidtmann, have recently directed attention to this kind of

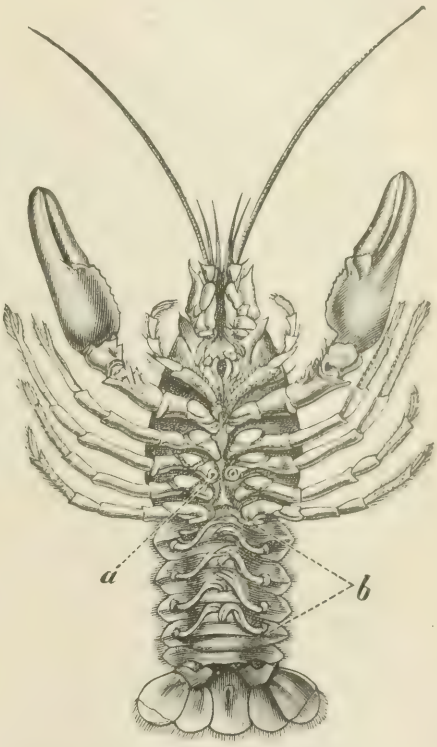
fore, be excluded from the market. This decision was based chiefly on the statement of an expert meat inspector that the meat of crawfish rapidly passes

Fig. 250.



Male crawfish. *a*, copulatory organs; *b*, swimmerets.

Fig. 251.



Female crawfish. *a*, opening of the genital organs; *b*, swimmerets.

into decomposition. The sale of dead lobsters and fish, as is well known, is not to be prohibited so long as it shows no decomposition. In addition to the determination of cadaverous alterations in crawfish, the recognition of the sex is of interest, since in certain parts of the country closed seasons are prescribed for female crawfish. The male is slenderer than the female and possesses only three swimmerets, while the female has four (Figs. 250, *b*, and 251, *b*). Furthermore, in the male the copulating organs (Fig. 250, *a*) are found in front of the first pair of swimmerets, and in the female the opening of the sexual organs at the base of the second pair of swimmerets (Fig. 251, *a*) are diagnostic characters.

intoxication, which was observed by Vancower in 1800. The etiology of mytilism, however, is not fully explained, in spite of the numerous investigations which were made in the cases which occurred in Wilhelmshaven.

Nature of the Poisoning.—Brieger considers the toxic body to be a leucomain (mytilotoxin), which he succeeded in isolating from the clams, especially from the liver. The origin of this body was not determined. It is a matter of fact, however, that certain "poison areas" are found in the water along the coast, in which clams are uniformly poisonous.

Recognition of Poisonous Clams.—According to Schmidtmann and Virchow, poisonous clams are less pigmented (lighter with radiate streaks), while non-poisonous specimens are uniformly darkly pigmented. Furthermore, the shells are less firm, more friable and broader than in non-poisonous clams. The liver is larger, softer and rich in fat and pigment.

Prophylaxis.—Springfield recommends that the public be warned against buying dead clams (those which do not close the shell when taken out of the water). Furthermore, the public should be warned against eating the liver and the broth. The former is the principal location of the toxin, which is extracted by water. Finally, it is recommended that the clams be boiled in a soda solution, since the toxin is thereby destroyed with certainty. The excess of alkali after boiling may be easily removed by the addition of a few drops of hydrochloric acid.

Relationship Between Mytilism and Botulism.—Mytilism, even in a paralytic form, has, according to van Ermengem, nothing in common with botulism. For, in mytilism the pathological symptoms appear within one-fourth to one-half hour after eating, and death within a few hours at the outside. Moreover, the disease quickly runs an acute course and is not ushered in with long-continued ocular disturbances as in botulism. Finally, mytilotoxin resists high temperatures, while the toxin of botulism does not. Mytilism must, therefore, be considered as an intoxication *sui generis.*

(c) Poisoning from Oysters.

As shown by experience, the eating of oysters may lead to slight or serious cases of illness. Slight cases consist of urticaria and albuminuria; more serious cases in violent gastro-enteritis. Cases have been observed in which cholera-like symptoms developed after eating a single oyster.

Etiology.—The cause of oyster poisoning, like that of clam poisoning, is still doubtful. Formerly, it was assumed that coloring oysters with verdigris in order to give them the appearance of the so-called groenbarden * was the cause of the poisoning.

This assumption, however, can not be brought into harmony with the phenomena of ordinary oyster poisoning. According to Bardet, all oysters are diseased during the summer. Bardet, however, was unable to determine the nature of this disease. He merely found that diseased oysters possess a characteristic milky appearance and that the liver is enormously enlarged, gray and soft.

Prophylaxis.—In view of the fact that oysters are poisonous only in the summer months, their sale has long been prohibited during the months from May to August. This prohibition is perfectly justifiable. In very warm early autumns, or Indian summers, cases of poisoning may occur in September and October. Moreover, the public should be warned against eating dead or decomposed oysters.

When removed from the water, good oysters close the shell, react to touch with movements, are of medium size and bluish color and exhibit a clear, pure, fluid inside the shell. In the case of dead oysters, the shells remain open, while decomposed oysters are discolored, very soft, do not smell fresh and also exhibit a blackish ring on the inner side of the shell.—*Springfield.*

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* The so-called groenbarden, or Marennes oysters, acquire their natural green color from the sea water in which they are placed as soon as captured, and in which they are kept for months, during which time they are fed on a species of seaweed, *Navicula ostrearia*. The seaweed contains the coloring matter called by Ray Lankaster, marennin, which is deposited in the cuticular cells of the gills and which is bluish of itself, but is changed to green by the normal brownish or yellowish color of the gills.

Oysters which contain copper are not dark-green, but grass-green, and exhibit a verdigris-like, slimy secretion of the folds of the mantel. After the addition of vinegar, a fork becomes encrusted with copper when stuck into the oysters, and when ammonia is added, the oysters become dark-blue.—*Springfield.*

XV.

ADDITION OF FLOUR TO SAUSAGE—COLORING AND INFLATION OF MEAT.

1.—Addition of Flour to Sausages.

General.—At stock shows and also on other occasions, butchers never fail to insist upon the fact that the aim of hog raising runs directly counter to the interests of meat dealers, for in all cases an attempt is made to produce as early and as large a deposition of fat as possible. Butchers claim that such hogs are not suitable for manufacturing into sausage, since they do not render possible the preparation of a sausage with good keeping qualities and do not furnish a good "combining" mass for so-called kochwurst or brühwurst.

By the term "combining power of meat" is understood the property of absorbing water. The combining power is due to the swelling capacity of muscle albumen (Hofmann). In highly fattened animals which mature late, this swelling capacity is greater than in animals fattened on large rations of manufacturers' byproducts and which have reached an early maturity. In the last named animals the combining power of the meat, especially in summer, is said to be slight. Dry, firm fibers have the power of absorbing the most water; moist and flabby fibers, the least. According to Trillich, and his statement is confirmed by others, it is possible for 100 parts of sausage to absorb as much as 70 parts by weight of water.

It is a highly remarkable fact that in beef the absorptive power for water may be artificially increased by working it up in a fresh warm condition and either pounding it vigorously or deviling it. Pork with a low combining power may have this property increased by salting, frequent turning, or by the addition of beef and veal. The combining power of pork may be also increased by adding eggs or dry albumen (100 to 200 grams allowed to swell in one liter of water per half centner of sausage material).

The custom of mixing flour with the meat in the preparation of kochwurst or brühwurst, in order to give the material the necessary combining power, is attributed to the defective combining power of meat. There are no reliable data concerning the time when, or the place where, this custom originated. Berlin and Leipsic butchers testified in court during the 80's of the previous century that the custom of adding material to the sausages above named had been established for "about ten years," and that this method of manufacturing sausage had been introduced from southern Germany. The butchers in southern Germany, on the other hand, reported that in "southern Germany since ten or fifteen years" it had been the custom to add flour to sausage pulp. However that may be, it is a matter of fact that at the present time the addition of flour to sausages intended for immediate consumption has become a widespread custom in Germany.

The following facts were obtained by means of a circular letter addressed to the German Meat Dealers' Union:

In the province of Hanover, it has been customary since "grandfather's" time to prepare sausage mixed with milling products. In Voigtlandt and Erzgebirge, it is customary to add about 2 per cent. of starch flour to all brühwurst. In Rheinland and Westphalia, the addition of potato flour to a number of kinds of sausage is generally practiced, although there are certain butchers who use only animal products. The meat dealers in Köln assert that the addition of flour is absolutely unnecessary in the case of sausages intended for long keeping (cervelatwurst, blockwurst, etc.); that the addition of 2 or 3 per cent. is sufficient for different kinds of kochwurst, such as fleischwurst, leberwurst, mettwurst, frankfurters, etc., while for ordinary leberwurst or brühwurst, the addition of 5 to 8 per cent. of flour is considered customary. In the Kingdom of Würtemburg, according to the statements of the Butchers' Union, the preparation of fresh sausages, genuine bratwurst, from pounded young beef or veal, with the addition of milk, eggs and 2 to 3 per cent. of wheat flour, has been customary from time immemorial and has never been condemned by the authorities. In the Province of Brandenburg, the addition of 2 to 4 per cent. of starch material to röstwurst is considered necessary. It was reported from Magdeburg that it was not customary to add any considerable quantity of flour to sausage, and finally, from Silesia and East Prussia it was reported that the addition of flour to sausage was unknown or not practiced.

The materials for the technical basis of the draft of the food

law contain the statement that many butchers have found that even small quantities of starch flour or ordinary flour, when cooked with water, may absorb a large quantity (50 times its volume) of water and that thereby a thick, firm paste is formed. Butchers are said to have taken advantage of this property by adding such paste to the sausage. Against the oft-repeated assertion that the addition of flour belongs to the sausage, it must be objected that, especially in private houses, good sausages are frequently made without any addition of paste.

It was then an important duty of chemical experts—in addition to the demonstration of coloring matters artificially added to meat and the only duty which fell to the chemists with respect to the supervision of the meat traffic—to demonstrate flour in sausages, for this demonstration is very simple. The simplicity of the demonstration in connection with the above mentioned statements of the materials for the basis of the food law brought it about that after the passage of the food law a very large number of prosecutions were made for adding flour to sausages, and these cases, through the testimony of witnesses and the accurate investigations of experts, brought to light some surprising facts concerning the operation and purpose of the manipulation in question. The final result could not be brought into harmony with the statement in the materials for the basis of the food law, and the latter, therefore, can no longer be considered as an accurate foundation for a legal judgment of the addition of flour to sausages.

For the better understanding of the question at issue, it is necessary to devote a little time to the customary method of preparing meat for sausages, especially with regard to the manufacture of kochwurst or brühwurst intended for immediate consumption. With regard to the two last named kinds of sausage, very important criteria are contained in an opinion of Prof. Hofmann in Leipsic, which was requested by the Landgericht in Lübeck.

Different Kinds of Sausages.—Distinction is made according to the material which constitutes the chief element of the sausage between visceral sausages (lungwurst, leberwurst, hirnleberwurst), sülzwurst, which contain a considerable amount of skin from the head and feet (schwartenmagen, presssack, head cheese, "calf's feet," etc.), blood sausages and lastly meat sausages. Meat sausages are again divided into those which are intended for long keeping (cervelatwurst, schlackwurst and mettwurst) and bratwurst, kochwurst and brühwurst. The latter are known in different parts of

Germany under the names saitenwurst, knoblauchwurst, wienerwurst, bierwurst, knackwurst and jauerschewurst.

PREPARATION OF KOCHWURST AND BRÜHWURST.—In contrast with the sausages intended for long keeping, in making which the chief aim is to secure the best possible keeping quality, the method of preparing kochwurst and brühwurst is such that an immediate consumption is required, not only on account of the slight keeping quality of the sausage, but also in the interest of the manufacturer and dealer. The water content of the meat mass which is used in preparing these sausages is artificially increased. Kochwurst becomes more unsightly from day to day on account of the evaporation of water, which, in consequence of the delicate casing, takes place much more rapidly in kochwurst than in other sausages. For this reason it is to the interest of dealers, as already mentioned, that the sausage should be consumed as soon as possible. The sausages are exposed for a short time to hot smoke and immediately before being eaten are either cooked or, more frequently, placed in water at a temperature of 70° C. for about 20 minutes.

The addition of water to the minced meat in the preparation of kochwurst is absolutely necessary for two reasons:

In the first place, without an addition of water to the minced meat it is impossible for the sausage maker to prepare a meat mass of the proper consistency for injecting into the thin-walled casings which are used and which must be used in the manufacture of brühwurst. Thin-walled casings must be used, since in the case of brühwurst the casing is not removed, as in the other sausages, but is eaten along with the sausage by the great majority of consumers.

In the second place, the high water content of kochwurst or brühwurst is an essential character required by the consumers. The public desires a "juicy" bierwurst with a homogeneous, coherent and non-friable cut surface. The juicy character and the homogeneous structure of the sausage, however, can not be secured without the addition of water. The natural water of the meat is not sufficient to render possible the preparation of a juicy kochwurst. For purposes of comparison, Hofmann had brühwurst prepared without the addition of water. Although the fresh meat paste possessed a water content of 76.5 per cent., corresponding to that of fresh meat, the water content of the meat paste in the sausage was lowered to 51 per cent. as a result of smoking. The sausages, the dry matter of which had increased 49 per cent., were hard, tough and dry. It was necessary to masticate the firm mass a long time before it

could be swallowed. Hofmann says that the sausages were "simply of a quality such that they could not be sold as juicy, soft brühwurst." The addition of water is, therefore, made, not to increase the weight of the sausages, but to lend them quite specific characters which are demanded in brühwurst.

From the experiment of Hofmann it is apparent that the demand of consumers for a juicy brühwurst is not unreasonable, if we consider merely the palatability of the material. This, however, is the essential feature in the kind of sausage in question. Hofmann rightly says: "On account of the necessary addition of water to brühwurst, this sausage is no longer a pure meat sausage. Brühwurst and kochwurst, as usually prepared, do not possess the nutritive value of pure meat." Hofmann also demonstrated that the weight of sausages found on the market varied considerably (from 34.1 to 40.1 grams, or about 17.6 per cent.). This fact indicated very clearly the difference in value between sausages intended for long keeping and kochwurst. The former are bought by weight. In the case of brühwurst the public does not ask concerning the weight. As Trillich says, it is literally true that, in the case of brühwurst, we eat water with a fork; but in these sausages we do not pay for the nutritive value, but for the taste.

Water Content of Brühwurst.—The quantity of water which is added in the preparation of the meat mass varies. More water is added to good dry meat than to that of a watery character, since the latter possesses smaller powers of imbibition. Sausage makers determine the required amount of water for different qualities of meat, not according to the determined weights, but according to the feeling. Water is added to the meat mass until it acquires the proper consistency according to the view of the sausage maker. According to Hofmann, the amount of water added amounts to 24 per cent. However, the amount of water added is illusory, since the sausages lose water during smoking and drying, and are, therefore, sold with a considerably lower water content. Hofmann found that the water content of sausages immediately after smoking was only 60.6 to 64.8 per cent. The sausage mass had, therefore, lost during the process of smoking not only the quantity which was added artificially, but also 10 to 15 per cent. of the natural water of the meat.

Is Starch Flour Absolutely Required in the Preparation of Brühwurst?—This question must be answered in the negative; for

there are butchers who prepare brühwurst without the addition of flour. Furthermore, in legal processes, on account of the addition of flour in Regensburg, Munich and Coblenz, it was considered as demonstrated that the addition of flour was not customary and also that the public expected to obtain pure meat sausages when buying brühwurst. The addition of flour to meat masses intended for brühwurst can, therefore, not be considered as an absolute necessity, since good meat possesses a sufficient combining power to absorb the required quantity of water and since the trade has recourse to other means than the use of flour for increasing the combining power of meat (page 770).

The preparation of brühwurst without the addition of flour must, however, be characterized as exceptional in Germany. As a rule, flour is added, especially patato flour, to which also the name of "strength flour" is given for reasons which are not apparent. The resolution of a "Congress of Sausage Makers," at which a majority of the delegates decided that the addition of 2 per cent. of flour to certain sausages was necessary, furnishes proof of the extent of the custom of using flour in the manufacture of brühwurst. The Butchers' Union in Bremen declared in the form of a resolution that the use of flour for improving the quality of certain kinds of sausage had been customary for years; moreover, that this addition is not considered as a fraudulent practice by the dealers is apparent from the fact that, as stated by Hofmann, brühwurst was prepared with the addition of flour before the eyes of the public at a cooking exhibition in Leipsic.

Does the Addition of Starch Flour Render Possible an Unusually High Water Content, or Does it Prevent the Loss of Water in Smoking and Drying?—It must be considered as a happy thought on the part of the Landgericht at Lübeck that it had careful experiments instituted in the form of a sausage test for obtaining light on these points. Sausages were prepared without potato flour, with 0.8 per cent., and also with 2 per cent. potato flour. (Sample I. without flour, but with the usual addition of water; Sample II. with 0.8 per cent. potato flour and with the usual 8 per cent. of water; Sample III. with 2 per cent. of flour and as great as possible an addition of water; Sample IV. without flour, but with the same amount of water added as in Sample III.). The experts who were requested to test the sausages, Pharmacist Schorer and Prof. Küstermann, summarized the results of the test as follows:

1. For the regular preparation of bierwurst, 18 parts of water must be added to every 100 parts of meat in order to produce a workable raw mass.

2. In smoking such sausages, which, as a rule, occupies one-half hour and is carried out in a sort of fire-place, or over a free fire, the mass loses about 11 parts of water; so that a bierwurst is obtained with 7 parts of water to 100 parts of meat.

3. The addition of 0.8 per cent. potato flour to the meat mass is without any decided influence upon the water content of the sausage. The sausage is not thereby altered either in external appearance or in taste after cooking; that is, in the case of meat with a good combining power.

4. With the addition of 2 parts of potato flour, as much as 70 parts of water may be mixed with 100 parts of meat for obtaining a raw mass for the preparation of bierwurst.

5. The same quantity of water, however, 70 parts to 100 parts of meat, may be added also without the use of potato flour.*

6. In smoking, Sample III. (with 2 per cent. flour) and Sample IV. (without flour) lost about the same amount of water immediately after smoking, or 32 and 35 parts respectively. After hanging 24 hours in the air, the loss increased to 42 and 44 parts of water, so that the bierwurst, when ready for consumption, consisted of 100 parts of meat with 28 or 26 parts of water.

7. The addition of potato flour, at least in quantities up to 2 per cent., does not, therefore, make possible the utilization of a larger quantity of water in the sausage mass than could be accomplished with the meat mass alone without the addition of potato flour.

In any event, this quantity of water must be estimated as considerably less than 70 per cent. of the raw mass, or less than 26 per cent. of the 100 parts of meat in the smoked sausage when ready for consumption, if the bierwurst is to be as saleable as the ordinary market form of this sausage.

8. From a comparison of the loss of water from Sample I. (without flour) and Sample II. (with 0.8 per cent. flour) or from Sample III. (with 2 per cent. flour) and Sample IV. (without flour), it appears "that the amount of water lost in smoking depends upon

* Trillich also demonstrated this fact. At the Sixth Session of the Free Union of Bavarian Representatives of Applied Chemistry, he characterized the influence of the addition of starch flour upon the water content as illusory, since it is possible to combine an equally large quantity of water in a sausage mass which contains no starch flour.

the amount of water added to the raw sausage mass and that this is not influenced by the addition of potato flour, at least when used in quantities up to 2 per cent."

These experiments show that the addition of a small quantity (up to 2 per cent.) of starch flour does not injure the quality of the sausage in the sense of making it more watery than would be possible without this addition. The essential point in the views expressed in the materials for the technical basis of the food law concerning the effect of the addition of flour is, therefore, robbed of its force. Moreover, on the occasion of the legal proceeding in Lübeck, Schorer called attention to the fact that it was a gross error to assume, as was done in the materials for the basis of the food law, that 1 part of starch flour in 50 parts of water furnishes a thick, firm paste. The experiments instituted by him showed that 1 part of starch flour boiled in 50 parts of water gives a fluid substance which could readily be poured in drops. A firm paste could be obtained only by cooking 1 part of flour with not more than 10 parts of water. In general, it was shown that potato flour does not absorb water except when boiled; that the materials are added to the sausage in a cold form and not, at least not as a rule, in the form of a paste, as assumed in the materials for the basis of the food law. Furthermore, the sausages in question are usually not boiled, but, as stated by Bischoff, steamed at a temperature of 70° C.

Demonstration of Starch Flour.—This demonstration may be conveniently made, chemically, by the use of Lugol's solution, with which the cut surfaces of the sausage to be tested is touched. If starch flour is present, the characteristic blue color is produced in a diffuse distribution over the whole cut surface.

Furthermore, the addition of flour may be demonstrated by the microscope. Brüller states that for accuracy he prefers a microscopic demonstration. He argues that the iodine reaction proves nothing with regard to the presence of starch flour, since pepper is also normally present in sausage and this may give a fine iodine reaction, even in great dilution, with 5,000 times its quantity of water.* It was further stated by Brüller "that under the microscope the starch of pepper could be readily distinguished from that of potatoes, since the starch granules of pepper are considerably

* According to Lehmann, the amylum of the seasoning is not sufficient to produce a microscopic, diffuse, blue coloration on the cut surface of the sausage after treatment with iodine.

smaller and never show the concentric striation with the excentric nucleus of potato flour. As Brüller rightly observes, amylum granules are for the most part demonstrable in the unaltered condition, since, as a rule, flour and not paste is added to the sausage mass, and since amylum granules, as shown by Schorer, undergo no alteration during smoking at a high temperature.

Histology of Potato Starch.—The starch granules of potatoes are on an average 45 to 75 μ long, 45 to 65 μ wide, round or elliptical (oyster-shaped). The excentric nucleus lies almost always in the narrower portion. The striæ are not uniform, but are mostly fine and sharp (draft of the *Codex Alimentarius Austriacus*).

Quantitative Demonstration of Starch.—In order to determine the quantity of starch flour which has been added to meat products, the so-called inversion method has heretofore been used successfully. By this method the amyloid substances are changed, by the action of dilute acids under high temperature and pressure, into sugar, and the latter is determined.

A second method of procedure was described by Mayrhofer. According to this method the material to be examined is dissolved by the application of heat on a water bath in about 8 per cent. alcoholic potash lye without the addition of sand for the purpose of a better distribution. In the case of pure sausages, scarcely any residue is left except cellulose, since the casing is also dissolved. After the material is dissolved, it is diluted in warm alcohol in order to prevent gelatination. Any insoluble residue which may be present is placed upon a paper or asbestos filter and washed with alcohol until the alkaline reaction disappears. It is then treated with an aqueous solution of potash lye and thereby the starch is brought up to a definite volume. If, now, the alkaline solution is treated with alcohol, the starch is precipitated in flakes and settles rapidly to the bottom. After filtration upon filters of known weight and washing with alcohol and, finally, with ether, the quantity of starch may be easily determined.

In order to avoid a determination of the ash, it is desirable to produce the precipitation, not with alkalies, but with a solution slightly acidified with acetic acid, since the acetate of the carbonate of potash which is contained in abundance in the starch is easily soluble in alcohol. In this manner we obtain starch free from ash. The results show the quantity of pure starch, not the original quan-

tity of flour added. The method is, therefore, not strictly accurate, but it is quite as accurate as the previous method of inversion. Since the distribution of starch in the sausage is not uniform, it is desirable to take not merely a few grams for samples, but pieces weighing from 60 to 80 grams.

Experiments with sausages artificially diluted with starch flour have shown that the starch which was originally used can be demonstrated by the method of Mayrhofer, either in its entirety or at least within a few milligrams.

HYGIENIC AND CULINARY JUDGMENT OF THE ADDITION OF FLOUR. —Hofmann rendered an opinion, in harmony with Schmidt-Mülheim and Schorer, that the addition of flour does not promote the decomposition of sausages; that sausage paste decomposes with equal rapidity whether with or without the addition of flour, and that, therefore, the assumption of a harmful effect from the addition of flour is unjustifiable, since the starch flour belongs to a class of bodies which decompose with difficulty.* Finally, Hofmann calls attention to the fact that a slight addition of starch flour improves the quality of sausages. The juice of the sausage is thereby rendered thicker and therefore remains longer on the tongue. Moreover, it is asserted that the addition of flour renders possible the use of larger quantities of spice in the sausages, since it operates at the same time as a diluting and enveloping medium. Hofmann claims that flour is therefore added even by very reliable dealers, since sausages containing flour are preferred by the public. As a result of the addition of flour in limited quantities, Schmidt-Mülheim observed an improvement in the quality of sausage, due to the fact that the starch flour helps to combine the sausage mass and prevents its escape from the casing.

LEGAL JUDGMENT OF THE ADDITION OF FLOUR TO BRÜHWURST. —No hygienic scruples can be held against the addition of flour to brühwurst. There is, however, a further question, whether a material injury is not caused to the consumer through the addition of flour, and whether sausages containing flour must not be considered adulterated.

Under the head of adulterated food materials (page 102), we

*In the case of blood and liver sausages which are diluted with flour to the extent of 10 per cent. and which are not at all or only partially smoked and have been preserved for a long time, a noticeable souring may take place before true meat decomposition sets in (Bischoff).

understand those which do not possess the properties which are expected in actual trade. The conditions of adulteration are not fulfilled if the addition of flour is customary in the locality in question—and that is the case in the greater part of Germany—and if the quantity of flour added does not exceed 1 to 2 per cent., which is the usual quantity in trade.

On the other hand, the addition of flour must be considered as an adulteration in localities where it is not customary;* or if it greatly exceeds the above named limits so that it amounts to an actual and substantial depreciation of value, or to a considerable replacement of meat with flour. Greater quantities than 1 to 2 per cent. are added to the sausage mass only with fraudulent intent, since, according to the statements of reliable dealers, 1 to 2 per cent. is sufficient in order to lend the sausages an appetizing taste.

It must be characterized as an adulteration when flour is added to sausages other than brühwurst, particularly to sausages which are intended for long keeping, since in the latter the addition of flour is neither customary nor necessary.† Similarly, the addition of flour to minced meat is undoubtedly a gross adulteration.‡

The Reichgericht, in a judgment rendered October 4, 1883, declared that it is a case of adulteration when a paste consisting of potato flour and water is added to sausages, contrary to the custom which prevails at the locality where the sausage is prepared and according to which pure meat sausages are understood by the terms used.

Furthermore, in the case of the Regensburg butchers (Criminal Senate I, Judgment of September 23, 1883), the Reichgericht rendered a similar decision. These butchers had added 1 to 5 per cent. of flour to presssack, speckwurst, blutpresssack, weisswurst and Parisian sausages. It was held to be a settled fact that in

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* In such localities, dealers may protect themselves against legal procedure by the use of placards such as are employed in Wiesbaden (page 781).

† Bischoff calls attention to the fact that in the case of sausages which are boiled before smoking a very different judgment should be rendered than in the case of brühwurst, in which smoking is done first. In material which is first cooked, as, for example, liver sausage, the starch is changed to a paste by the process of boiling. This paste yields up only a part of its water during smoking, and in such products, subsequently sold according to weight, an abnormally large water content is present as a result of the addition of flour.

‡ The addition of "albumina" is also an undoubted adulteration. Albumina consists of tragacanth and albumen and when added to the extent of 3 per cent. renders possible the preparation of a sausage paste which consists of 70 pounds of meat to 100 pounds of water.

Regensburg the addition of flour was not a common custom and that the public did not know or expect that it was purchasing anything else than material prepared purely from parts of the animal body with the addition of spice.

Likewise, the Reichgericht (I. Judgment of January 7, 1887) decided that in Munich the addition of 4 to 5 per cent. of starch flour to sausages was an adulteration, since such an addition in the place in question was neither a common custom nor expected by the public. It was held also that the trade practice could not be considered as deciding the question in itself, merely according to the wish and practice of the producers, but that the reasonable expectation of the public must also be considered.

On the other hand, the addition of a small quantity of wheat bread to rostbratwurst (10 to 12 pfennig worth to 5 kg. of meat) was not considered as an adulteration if in the region in question such an addition was "by no means an unknown or unexpected admixture," and if, on the contrary, "according to the view of the public," wheat bread is a necessary constituent of a palatable bratwurst (Decision of Criminal Senate III, December 21, 1882).

Finally, on December 3, 1894, the Reichgericht decided that the addition of flour to cervelatwurst, in however small quantity, must be considered as an adulteration.

The Royal Prussian Landgericht at Coblenz declared that in Coblenz, according to the practice of the reliable tradespeople, nothing but meat (beef or pork), except the necessary seasoning, is to be used in the ordinary preparation of meat sausage and that other additions (liver, lungs, sardines, etc.) are to be indicated in the name of sausage. It was held that flour could not be considered a normal constituent of meat sausage. Nevertheless, the defendants, who had used flour to the extent of 3.3 per cent., were discharged for the reason that they had added the flour merely as a combining material without knowing that it was not allowable, and without the intention of deceiving.

The Landgericht in Frankfurt decided that the addition of two per cent. of flour as combining material was permissible.

In Wiesbaden and Giessen, any addition of flour to sausage is considered as punishable. For this reason it has become the established custom of sausage dealers to display placards in their salesrooms with the inscription "sausage with combining material." The dealers thus escape liability of punishment by this declaration. Likewise, according to a decree of the council in Dresden, April 8, 1899, any addition of flour to sausages is considered punishable.

On the other hand, the utilization of wheat bread in the preparation of so-called semmelleberwurst is not condemned on account of being a local custom. Also in the Grand Duchy of Baden, no addition of flour is permitted (Ministerial Decree of March 17, 1897).

Note.

Other Adulterations with Inferior Material.

With regard to other adulterations in meat traffic and in the manufacture of sausages, a proper decision can easily be reached in accordance with the previous discussion and after consideration of the meaning of the term adulteration. In all cases the essential points which determine the fact of deception are the determination of the prevailing custom of preparation among reliable dealers and the reasonable expectation of the consumers in buying the products and also the price.

According to these points of view, the addition of a small quantity of wheat bread to rostbratwurst was not considered as an adulteration in the decision of the Reichgericht, December 21, 1882. Similarly the utilization of wheat bread in preparing fresh blood and liver sausages in Berlin was not considered an adulteration since this method of preparation was quite common and well known (Bischoff). On the other hand, the utilization of testicles, uteri, with or without the fetus, beef head, etc., in the preparation of sausages, undoubtedly constitutes an adulteration.

Special attention may be directed merely to an adulteration, the detection of which is in other respects the function of a chemist —namely, to the adulteration of lard with cottonseed oil. This oil is added in large quantities to American lard. According to Sendtner, for example, among 110 samples of American lard examined in Munich, not less than 72 were adulterated with cottonseed oil, while, according to Stein, 14 out of 78 samples inspected in Copenhagen were likewise adulterated. The addition of this vegetable oil amounted to 50 per cent. or more, so that the mixture should not properly have borne the name lard. So long as the American fat mixture is sold under proper declaration, no objection can be made to it. *Volenti non fit injuria.* On the other hand, the practice of mixing domestic lard with the American material and selling this mixture under the name and for the price of the former should be checked.

The demonstration of cottonseed oil in lard may be made by determining the iodin number (page 219). According to Neufeld, the iodin number of lard is 46 to 61. Cottonseed oil raises the iodin number, while it is lowered by the addition of beef tallow.

Governmental Regulations Against the Adulteration of Lard.

According to the Imperial law concerning traffic in butter, cheese, lard and other substances, June 15, 1897, all lard-like preparations in which the fat content does not consist exclusively of pork fat, must be declared as "artificial food fat." The following statement concerning the meaning of this term is contained in Section 1:

"Artificial food fats in the sense of the law include preparations resembling lard in which the fat content does not consist exclusively of pork fat. Exception is made in favor of unadulterated fats of certain animal and vegetable species which are exhibited under names which indicate their origin."

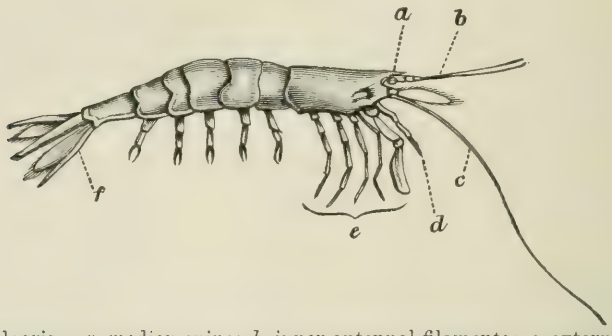
Adulteration of Caviar.—A work of Niebel contains some very interesting statements concerning adulterations of caviar. In Germany, according to Niebel, fluid or granular caviar is almost the only kind found on the market. More rarely pressed or so-called servietten-caviar is observed. The best caviar is the Russian; the American is next best; the third best is the Elbe caviar.* The Russian caviar is coarsely granular and free from membranes and mucous admixtures. In judging caviar, attention should be given to the color, consistency, size of the eggs and the odor and taste, as well as the purity. According to Niebel, caviar is to be considered spoiled when it contains foreign admixtures or when it is rancid or possesses a mouldy or bile-like, bitter taste. On the other hand, it is to be considered as adulterated when foreign materials, like bouillon, white beer, oil or sago are added. Sour caviar is of inferior quality. The border line between inferior and rancid caviar, according to Niebel, is at the point of 4.5 per cent. of free acid content. The content of common salt in samples of caviar which were examined amounted to from 6.15 to 11.4 per cent. Strongly salted caviar is of inferior value and caviar saturated with salt is not suit-

*Concerning the quality of the Elbe caviar, Bischoff states that as a rule it is a suspicious product. Sturgeons are at present almost never observed in the Elbe. It is asserted that the product which is sold under the name Elbe caviar is usually decomposing American caviar which has been subjected to a subsequent process of preservation.

able for human food. Likewise, decomposing caviar must be characterized as unfit for food. As helps for judging caviar, it is recommended that the reaction be determined; furthermore, that a quantitative demonstration of free fatty acids and salt be made, and, finally, that the amount of free ammonia and sulphuretted hydrogen be determined.

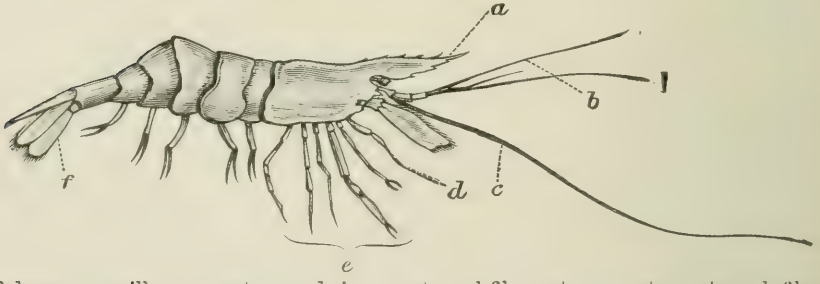
Adulteration of Shrimps.—Two kinds of so-called shrimps occur on the market: the common shrimp (*Crangon vulgaris*) and the

FIG. 252.



Crangon vulgaris. *a*, median spine; *b*, inner antennal filaments; *c*, external antennal filaments; *d*, third appendage; *e*, the five ambulatory appendages; *f*, sixth abdominal appendage. (After H. Raebiger.)

FIG. 253.



Palaemon squilla. *a*, rostrum; *b*, inner antennal filaments; *c*, outer antennal filaments; *d*, third appendage; *e*, the five ambulatory appendages; *f*, sixth abdominal appendage. (After H. Raebiger.)

prawn (*Palaemon squilla*). The latter is the more valuable of the two, since it possesses a better flavor and is more edible than the former. It assumes an appetizing red color in cooking and is also rarer than the common shrimp. The price of common shrimp is 20 to 60 pfen., and of prawns, 1.6 to 3 marks per pound. This difference in price makes an adulteration of the last-named species a

profitable practice and this has recently been done by boiling, in fuchsin water, the common shrimp, which normally remains gray in cooking. Boiled common shrimps thereby acquire the character which ordinary people consider as the most important criterion for recognizing the prawn.

The adulterated shrimp or imitation prawn may, according to Raebiger, be recognized by the following characters: Red coloration of artificially-stained shrimps is spotted. Moreover, the broken off ends of the abdomen are totally stained and the eggs which are found under the abdomen are bright red. In some parts of the shrimp the coloring material penetrates even into the meat. Artificial coloring may also be demonstrated by boiling shrimps in alcohol. Artificially stained shrimps lend the alcohol a cloudy rose-red color, while with naturally red prawn the alcohol remains whitish yellow.

The prawn are characterized by the strongly projecting frontal spine, the long-peduncled eyes, the larger number of antennal filaments, the chelipers on a number of the ambulatory appendages and the bright-red telson, as contrasted with the short spine, short-peduncled eyes, less numerous and shorter antennal filaments, different anatomical structure of the ambulatory appendages and the darkly pigmented telson of the shrimp (Figs. 252, 253).

Fraudulent Treatment of Salmon.—According to Raebiger, the following salmon are found in trade: The Rhine, Weser, Elbe, American, Baltic, Volga or Russian, saltwater (common hake), and, finally, the façonlachs. The Rhine salmon (*Trutta salar*) is the most expensive. It costs from 5 to 8 marks per pound, and other species of salmon of less value are, therefore, frequently used to replace it. The Rhine salmon is distinguished by its rose-red color of slightly yellowish tinge, strong development of white fat, the elongated, oval, silvery-white scales, becoming black-brown toward the dorsal line, and also by the fact that the dorsal and ventral lines approach each other toward the head. The Rhine salmon swims up stream in a fat condition for the purpose of spawning and returns to the sea in a poor condition with pale meat. When caught returning to the North Sea, they are called poor "Rheinsalm." The Elbe and Weser salmon are identical with the Rhine salmon, but, according to the opinion of connoisseurs, are not so valuable as the latter. The American salmon* (probably

* The most important Alaskan salmon are King salmon, redfish, cohoes, humpbacks and dog salmon.—TRANSLATOR'S NOTE.

Oncorhynchus quinnat), which, on account of its coarse-fibered meat and very salty taste, brings a price of 2 to 4 marks, possesses a rose-red or brick-red meat, well developed intermuscular connective tissue and myomeres, and exhibits much less fat than the Rhine salmon. The salmon which occurs in the Baltic is less highly prized for its meat than the North Sea salmon; its meat possesses the typical salmon color, is very fat and its intermuscular connective tissue is less strongly developed than in the American salmon. The Baltic salmon during its migrations reaches the Weichsel and the Memmel, is identical with the Russian salmon and possesses small round scales. The Volga salmon is either an American or Baltic salmon. Saltwater salmon or hake (*Merluccius vulgaris*) is a species belonging to the gadoid group and not to the Salmonidæ. It is characterized by its almost white meat, which contains but little fat. Finally, do-over salmon (façonlachs), which is prepared by pressing together the waste pieces, is recognizable by the absence of the connective tissue strands, or by their regular course upon a cut surface.

2.—Coloring.

The artificial coloring of large pieces of meat, minced meat and especially sausages, belongs among the achievements of the most questionable sort, which characterize the modern meat industry.

Purpose.—The purpose of coloring meat varies. The materials for the technical foundation for the draft of the food law contain the statement that a sausage mass which has lost its natural coloring by the excessive addition of flour and water is frequently colored with fuchsin in order to conceal this defect. From a study of court proceedings it appears that the artificial coloration of sausages from this cause is less frequent than in the case of minced meat which is intended for sale as such. Furthermore, we learn from court proceedings that in recent times the coloration of meat is practiced rather extensively with the object of concealing the gray color of sausages intended for long keeping. This alteration of color is common in sausages, even in those which have been properly prepared (page 749). Bischoff asserts that until the authorities interfered in this matter, about 70 per cent. of all the sausages imported from Thüringen were colored for the reason just mentioned. At present, it is said, the percentage is much smaller. Finally, there are unscrupulous dealers who do not hesitate to give, by means of coloring materials, the appearance of

wholesome products to meat which has lost its normal color as a result of decomposition.

Kinds of Coloring Material.—The dyes which are used for coloring meat products are of various sorts. It appears that the first experiments in coloring meat were made with fuchsin. Since, however, this stain could easily be demonstrated, coloration with cochineal and carmin prepared from cochineal (ammoniacal extract of cochineal) came into use. Carmin is sold on the market under the name of "karnit." A very small quantity of either of these dyes is sufficient to produce a bright red color in the meat, since the staining power of these materials is very great. According to Falk and Oppermann, a carmin solution of 1:30,000 is sufficient to stain the meat red.

According to Marpmann, in addition to fuchsin and carmin, other dyes have recently been used for staining meat, including safranin, eosin and red vegetable dyes, from saturated stains of red berries, beets and roots to yellow crocus. According to Bischoff, moreover, azo-dyes have been used for this purpose. These materials are added under the most various names, in part calculated to deceive ("rosalin," "carmin substitute," "blood color," "blackberry red," "stabil," "cervelatwurst salt with spice," "alkermessaft)." Rosalin is a carmin preparation. Carmin substitute, on the other hand, is an azo-dye (Bischoff); blood color consists of starch colored red by anilin dyes (Baumert). Another anilin dye sometimes used is the so-called brilliant-berolina (Polenske). Corallin is used for coloring sausage casings. The use of this dye is forbidden by the law of June 5, 1887, concerning the utilization of injurious coloring materials in the preparation of food, for the reason that it frequently contains phenol. According to their effects, as shown by Juckenack and Sendtner, the dyes utilized in coloring sausages may be divided into three groups: (1) Those which stain the meat portions, but leave the fat uncolored. (2) Those which color finely minced meat and fat uniformly red. (3) Those which are soluble in fat and which consequently color finely or moderately finely minced meat and fat uniformly and throughout. If stained with members of group 1, the sausage when rendered contains uncolored fat, while, if stained with group 3, the fat is of a bright red color.

Demonstration of Dye Stuffs.—Lehmann recommends for the demonstration of fuchsin in sausages extraction with ethyl or

amyl alcohol. "If a distinct red coloring matter is dissolved out, the sausages are evidently stained with artificial dyes."

According to Fleck, comminuted meat samples are treated with amyl alcohol as long as the latter shows any red color. The larger portion of the solvent is distilled; the remainder is volatilized on the water bath and the residue dissolved in petroleum ether. The reddish-brown solution thus obtained is shaken together with absolute alcohol after the addition of a few drops of dilute sulphuric acid 1:4. The petroleum ether together with the fat which may be present then comes to lie as a layer upon the alcoholic fuchsin solution. The latter is repeatedly washed in a filter with petroleum ether until the ether leaves no residue of fat after evaporating. The alcoholic fuchsin solution, thus carefully obtained, is now diluted with an excess of ammonia. The ammonium sulphate which is formed is separated by filtration from the fluid which is now colored slightly yellow, and the latter is evaporated in a tared platinum or glass cup.

From 80 to 85 per cent. of the fuchsin used in coloring the meat should be demonstrated by Fleck's method.

For the demonstration of cochineal, Klinger and Bujard first suggested a method which is based on extraction by means of glycerin.

Twenty grams of finely minced sausage is boiled on a water bath with a mixture of equal parts of water and glycerin. If cochineal is present, a conspicuously red colored solution is obtained in a short time. In the absence of this dye, the glycerin is not at all stained or at most somewhat yellowish. After cooling, the solution is filtered and if only small quantities of the dye have been dissolved the process is repeated with the filtrate obtained from another 20 grams of sausage. The perfectly clear, and, what is of special importance, fat free, more or less red colored glycerin solution may, as a rule, be then directly examined by means of the spectroscope, during which the absorption bands characteristic of carmin may be plainly recognized in all cases. Otherwise the carmin-lac may be precipitated out of the solution in the usual manner. This substance is then collected upon a filter and dissolved in a small quantity of tartaric acid. A quite concentrated solution of the dye is thus obtained with which the usual reactions may be demonstrated.

According to Petsch, extraction with ammoniacal alcohol is a more rational method. By shaking the samples of colored sausage in a vessel containing ammoniacal alcohol, a more intensive colora-

tion of the filtrate appears than with glycerin extraction. Petsch, therefore, proposes, as a method for the demonstration of foreign coloring materials in sausage, that after negative results from the amyl alcohol test, the comminuted sample should be treated with a mixture of alcohol and ammonia by the cold method. Späth recommends extraction with a 5 per cent. solution of sodium salicylate as a preliminary test in the demonstration of carmin from analin dyes in sausage. The minced sausage is warmed on a water bath in this solution for fifteen minutes. It is then allowed to cool and is filtered. The filtrate is stained if artificial coloring materials are present. In old sausages (two years old) Polenske found that carmin was readily recognized by the color of the extract, while the analin dye (brilliant-berolina) was not. However, when the extracts were treated with dilute sulphuric acid, the salicylic acid was separated with a yellowish white color in the case of non-colored samples of sausage, while with sausages stained with carmin or brilliant-berolina, the salicylic acid was colored crimson.

In order to be able to demonstrate even small quantities of carmin, Bremer recommends that in suspicious samples of sausage, extraction of the coloring material should be attempted not only with alcohol, amyl alcohol, or alcohol and glycerin, but also with a slightly acidified (tartaric or hydrochloric acid) mixture of glycerin and water in equal parts. From this solution, which, moreover, in the presence of acids, is colored merely yellowish, the coloring material may be precipitated as lac. This is brought about by boiling the fluid with ammonia and diluting with water and allowing to settle. After twenty-four hours, if small quantities of carmin are present, a deep crimson precipitation is formed which may be collected on the filter.

On the basis of extensive experiments, Polenske considers a combination of the methods of Bremer and Spath as most suitable in demonstrating artificial dyestuffs in sausages. Polenske recommends a solution containing 5 grams salicylate of soda, 50 cc. of water and 5 cc. of glycerin. Twenty grams of the sausage is pressed into a paste, 30 cc. of the extraction fluid added, and the whole heated on a water bath for half an hour with repeated stirring. After cooling, the whole is pressed through gauze and filtered.

The presence of "carmin substitute" is easily demonstrated by a boiling test. In boiling a piece of sausage, the fat stains red and floats like red oil on water (Bischoff).

Marpmann and Späth recommend a microscopic examination as a certain method of demonstrating dyestuffs in sausage. Under

the microscope one recognizes artificial coloration by the fact that isolated portions of tissue paper appear to be stained red, while fresh tissue, even from smoked meat, exhibits a yellowish, yellowish-green or yellowish-gray color. According to Polenske, however, the microscopic demonstration of dyestuffs in smoked sausages is not easily made, while a chemical demonstration offers no difficulty, even in case of smoked sausages two years old. A microscopic examination, however, may serve as a test for orientation. Marpmann considers as most suitable the following method of microscopic determination of dyestuffs in sausage:

A piece of sausage to be examined is macerated in water. It is then saturated with 50 per cent. alcohol, after which the coloration of the salts may be recognized. Sausages which when covered with 50 per cent. alcohol possess a decolorized appearance after standing for two hours at ordinary living temperature must be considered as unstained, while, conversely, if the sausage still possesses a color, it is sufficient evidence of adulteration by artificial stains. If one treats a sausage with carbol xylol and replaces the latter with tetrachlòromethane, treatment with cedar oil renders the preparation more favorable for a microscopic examination.

Official Directions for Demonstrating Coloring Matters in Sausages.—The Berlin Police President issued the following directions for the demonstration of dyestuffs in sausages for the food control stations which are under the direction of the district veterinarians:

1. Small pieces weighing about 10 gm. of the sausage to be tested are placed in a test tube and covered with a mixture of officinal glycerin and water, so that the pieces of sausages are about 1 cm. beneath the surface of the fluid. If, after the test tube has been kept for fifteen minutes on a boiling water bath, the fat layer upon the glycerin or the glycerin water itself or both fluids are colored red the sausage must be considered as artificially colored with carmin or azo-dyes.

2. If by the application of the method just described a negative result is obtained, a piece of sausage weighing about 10 grams is to be placed in a cold mixture of officinal ammonia and water in the proportion of 1 : 3. If after some time the sausage exhibits violet red, or crimson spots, it must be considered as having been colored with carmin powder.

3. If these tests give a negative result, a portion of the sausage is to be heated in 95 per cent. alcohol. If the alcohol is colored

red the sausage must be considered as having been dyed with fuchsin.

4. The application of these methods is left to the discretion of the veterinarians.

Against the above directions, Weller and Riegel have raised the objection that they may fail to give results, since sausages which are made from meat prepared with saltpeter always yield a bright red colored fluid after treatment with the solvents mentioned in the above directions.

Weller and Riegel demonstrated by means of spectrum analysis that the coloring material, which is soluble in ether, alcohol and in aqueous and alcoholic glycerin, but which does not stain wool, is methemoglobin. The modification of the hemoglobin into a permanent red coloring matter under the influence of saltpeter appears to be a specific peculiarity of the hemoglobin of hog blood, since in a control experiment with calf's blood, only small quantities of yellow coloring materials were obtained in the ether which was used as an extraction reagent. The experiments which were instituted by Weller and Riegel, however, as indicated by Juckenack and Sendtner, do not correspond with actual conditions, for it never occurs in practice that meat sausages intended for long keeping are prepared by adding blood, since blood would reduce the keeping property of the sausages.

JUDGMENT.—The dye stuffs which are used for coloring sausages are not injurious from the nature of their composition, nor do they produce a substantial depreciation of the value of the meat or meat products on account of the quantity which is added. Nevertheless, from the standpoint of meat inspection and also from the legal standpoint, the addition of dye stuffs must be treated as an adulteration, and this is right and just.

It is undoubtedly a case of adulteration if the coloration deceives the consumer concerning the age of the meat, as in the case of mince meat, or with regard to the fraudulent addition of flour and water. It is an adulteration and also a violation of Sec. 12 of the Food Law if decomposing meat is colored and offered for sale,* for decomposing meat is injurious to health (page 757).

It is only in the case of the coloration of otherwise good sausage intended for long keeping that judgment may be doubtful.

* Reichardt (cited from Lehmann) describes an outbreak of illness which affected a whole family and was due to colored sausage. It is highly probable that in this case the sausage was prepared from decomposing meat.

This is done in order to conceal the gray color of the sausage and, according to the statements of Bischoff, is extensively practiced in Thüringen, but even in this locality the courts without exception condemn the practice on the basis of Sec. 10 of the Food Law, since fuchsin and cochineal are not constituents of normal sausage and since the addition of these dye stuffs is made for the purpose of giving the sausage the appearance of freshness and increased nutritive qualities. Moreover, Bremer rightly states that coloration may conceal not only the gray color, but also other decomposition processes in sausage, which may spoil the taste of the sausage. It is stated that in Munich sausages have repeatedly been examined which, at first glance at the fresh, smoothly cut surface, would be considered as excellent material, while they were absolutely inedible, except to a perverted palate. Thus, for example, in the institution for the examination of foods in Munich, cervelatwurst was found of very good external appearance, but exhibiting a rather bright red color on the cut surface. It possessed an acid content of 76 per cent., however, and was literally inedible. Moreover, with the utilization of azo-dyes, which give a red color to the fat, the appearance of pure meat sausage is produced.* Finally, it should be observed that hundreds of sausage makers in Gotha, which is the chief location for the manufacture of cervelatwurst, have declared that the prohibition of the use of dye stuffs would be to the interest of reliable dealers; for, with the help of dye stuffs, cheap American beef may be worked over into sausages, and thereby the good reputation of domestic sausages may suffer.

Decisions of the Reichgericht.—The coloration of the gills of fish with red dye stuffs in order to give them the appearance of fresh fish is an instance of adulteration (Decision II., Criminal Senate, December 2, 1891). Likewise, the coloration of sausage by means of dye stuffs in order to preserve the color of fresh products

* Juckenack and Sendtner have demonstrated by means of analyses that the addition of dye stuffs makes possible the preparation of sausage intended for long keeping with a higher fat and water content or, in other words, sausages which are of inferior value as compared with uncolored sausages.

The sausages exhibited the following average conditions:

	Deficiency in lean meat. *Per cent.*	*Excess of fat.* *Per cent.*	*Excess of water.* *Per cent.*
1 kg. colored mettwurst	22.96	14.68	14.68
1 kg. colored cervelatwurst....	22.67	7.44	14.92
1 kg. colored salamiwurst	22.41	7.19	15.56

for a period during which without such manipulation it would be apparent from the alteration of the natural color that the products were not fresh (Decision III., Criminal Senate, February 18, 1882).

The Position of the Imperial Health Office with Regard to the Coloration of Sausages.—Concerning the coloration of sausages, the Imperial Health Office has published a memorial, the gist of which may be stated in the following propositions:

1. If meat rich in natural coloring matter is utilized with proper regard to care and cleanliness, a uniformly red colored sausage, suitable for long keeping, may be prepared without the help of artificial dye stuffs.

2. The addition of dye stuffs makes it possible to lend the appearance of a better quality to a sausage which is prepared from less suitable material or with insufficient care, and the purchasers are thus deceived concerning the true character of the sausage.

3. In accord with the principles laid down by the Reichgericht, the majority of the courts which have considered this question assume that the artificial coloration of sausages, which has become established in many regions, can not be considered as legitimate business practice from the standpoint of the food law.

4. By the utilization of poisonous dye stuffs, the consumption of sausages colored with them may be injurious to human health.*

3.—Inflation.

Purpose.—The inflation of whole calves and sheep, as well as the lungs of these animals, is considered by the butchers as a tradition of their trade, so well founded that strong objections were raised when the authorities in many localities decided to prohibit the practice. Butchers especially assert that the process of removing the skins from the animals just mentioned is made much easier after inflation. Daily experience in abattoirs, however, where inflation is forbidden, teaches that skinning of calves and sheep—in the latter inflation is a much more general custom than in the former—does not offer any special difficulties, even without artificial inflation with air forced into the subcutaneous connective tissue. The

* By order of the Federal Council of February 16, 1902, the artificial coloration of meat and meat products, with the exception of the coloration of sausage casings, is forbidden in the whole German Empire from and after October 1, 1902.

actual reason of the objection of tradesmen to the prohibition of inflation from the side of the authorities is, therefore, doubtless, not the reason alleged, but another, namely, that it is possible, by means of inflation, to increase the apparent value of the meat. Meat is rendered more plump and of better appearance by inflation. It is very doubtful whether, as Schmidt-Mülheim assumes, it also becomes more appetizing. This appears to be a matter of taste. The effect sought in inflation is at any rate a possible advantage for the butcher in all cases in which poor, immature animals are concerned, which do not produce a favorable impression in the non-inflated condition.

In the case of the lungs, a volume is obtained by means of inflation which is not seen in them in the non-inflated condition. In this case it can not be denied that the organs are not only of better appearance, but that they exhibit a more appetizing exterior than when not thus treated. On the other hand, inflation makes it possible to substitute inferior hog and sheep lungs for the more valuable calf lungs. This substitution may be accomplished to the satisfaction of the laity more easily than when inflation is forbidden.

Schmidt-Mülheim mentions an increase in the keeping property of the meat as a hygienic advantage in inflation, provided that this operation is done by means of bellows with air filtered through cotton. The lymph which remains in the subcutaneous and intermuscular connective tissue is forced into the larger lymph vessels by the pressure of the air, and the drying-out of the subcutis, an important factor in the keeping quality of meat, is thus favored by the enlargement of the body surface due to inflation. In this connection, however, experience also teaches that we may well dispense with inflation without exposing the meat to a more rapid process of spoiling.

In addition to calves and sheep, light, poorly fed geese are also inflated, with fraudulent intent.

Technique.—Inflation is done in its simplest form by means of the mouth. As a rule, the lungs are inflated in this manner. For inflating whole animals, however, tradesmen usually employ a bellows. These possess a pointed canula, which is introduced into the subcutis in any part of the body through a slit in the skin. The air after being forced into the subcutis is distributed over the whole surface of the body by rubbing with the hand. Geese are inflated by means of a quill.

Recognition.—It is not difficult to recognize the inflated condition of a whole animal. This condition is apparent at first glance from the unusual size of the slaughtered animal and from the peculiar sheen exhibited by the subcutis in place of the cloudy character of the panniculus adiposus or of the pure white appearance of the subcutaneous tissue which is not filled with fat. A spongy feeling on palpation and a crackling sound are conspicuous.

The detection of inflated lungs is not so simple. The condition of such lungs is best understood by making an inflation experiment. If warm lungs are inflated by means of a tube inserted into the trachea, under slight pressure, the lungs swell greatly, the mediastinal surfaces come to lie in contact and the borders of the lungs become unusually sharp. The inflation is uniform and appears also in the anterior lobes, which consequently do not hang down or at the side, but stand out in the natural direction from the principal lobes. Moreover, as a rule, sub-pleural emphysema is observed as a result of excessive mechanical tension, and rupture of the alveolar walls by the pressure of the air.

All of these points should be carefully observed, for, since the prohibition of inflation has come into force, butchers have found another method of producing "large" lungs, which can not be condemned. This consists in the clever utilization of the mechanics of the thorax. After the exenteration of the abdominal cavity, and after the incision is made through the ischio-pubic symphysis, the animals are hung by the posterior extremities on gambrels, the hind legs are forced as far apart as possible, and the abdominal walls above the sternal cartilage are likewise forced apart by means of wooden braces. The artificial enlargement of the thorax causes an excessive inspiration into the air-tight lungs and this air is retained after the removal of the lungs from the thorax, if the removal does not take place too soon, but only after the appearance of a more or less complete rigor mortis. Such lungs with artificially increased inspiration are distinguished, however, from inflated lungs by their smaller size, less sharp borders, the absence of interstitial emphysema and, finally, by the flabby character of the anterior lobes. The latter possess only a medium air content, and, therefore, hang to the side or downward, for the artificial enlargement of the thorax on account of the natural anatomical conditions is greater in the posterior parts of the lungs and much less in the anterior parts.

A condition which resembles inflation is occasionally observed in the lungs of slaughtered cattle when aspirated fodder balls

become wedged in the trachea or in the chief bronchi, as a result of violent inspirations during bleeding, so that they can not be driven out again by expiration.

JUDGMENT.—While it can not be denied that the inflation of whole animals renders skinning easier and increases their keeping quality, nevertheless experience teaches that these advantages of inflation may well be dispensed with by tradesmen. Moreover, inflation is a trade custom the prohibition of which is justified for hygienic and commercial reasons.

With but few exceptions, consumers might reasonably reject a food material which is filled with the expired air of another person. In addition to the subjective feeling, however, it should also be remembered that in inflation by means of the mouth numerous putrefactive, often pathogenic, bacteria are inoculated into the meat and thus the advantage of increased keeping qualities is not realized, while under certain circumstances the meat may be given an actually dangerous quality. Putrefactive bacteria are also forced into the meat, even when the bellows is employed, if the filtering apparatus for the air recommended by Schmidt-Mülheim is not used in connection with the bellows.

Moreover, in any individual case it can not be determined whether the animal body or a lung has been inflated by means of bellows or with the mouth. A general prohibition of inflation is, therefore, sufficiently justified by the reasons which have already been mentioned.

It should also be remembered that the less observing purchasers may be deceived concerning the true character of the products in consequence of inflation and consumers may be enticed into buying meat which they perhaps would not have bought in an uninflated condition.

DECISION OF THE REICHGERICHT.—The Reichgericht declared in a decision of May 27, 1888, that inflated meat must be considered as spoiled in the sense of Sec. 367[7] of the Criminal Law Statutes, and must, therefore, be absolutely excluded from the market. The case in question concerned the offering for sale of a leg of veal which had been inflated with the mouth. The Reichgericht held that the meat into which air had been forced by means of the mouth was disgusting to the majority of consumers and was thereby, as well as from the fact of the danger of the transmission of pathogenic organisms from the person who inflated it, unsuited for ordinary con-

sumption. Moreover, it was considered that the meat was depreciated below its normal condition and was thus rendered of inferior value.

Prohibition of Inflation.—A circular letter of the Royal Prussian Ministries of February 13, 1885, recommends to the Government presidents the decree of a police regulation against inflation of meat. The inflation of meat with the mouth had already been prohibited by decree of the Ressort minister of August 17, 1861, and furthermore under the decree of November 15, 1879, the absolute prohibition of inflation was declared to be justifiable. Accordingly, the inflation of meat in Berlin as well as in the governmental districts of Königsberg, Frankfurt, Posen and Bromberg was forbidden.

The Prussian Kammergericht, on an appeal of a butcher against an unfavorable judgment of the Landgericht in Frankfurt, decided that police ordinances forbidding inflation were legal.

XVI.

PRESERVATION OF MEAT.

As with milk, so also with meat, we may speak of a certain keeping quality. While, however, in the case of milk, the keeping property may be endangered and destroyed by acid and zymogenic bacteria, in meat it is the putrefactive bacteria, those "ubiquitous organisms" which are everywhere present and which wait only for a favorable opportunity to induce decomposition in meat. The keeping property of meat depends upon various conditions. Attention has already been called (page 711) to the fact that the meat of animals slaughtered on account of disease is characterized by poor keeping property. For the rest, however, the keeping power of the meat depends chiefly upon the temperature and moisture content of the air in the room in which the meat is preserved. In cold, dry rooms meat keeps much longer than in warm, moist rooms. This fact finds its natural explanation in the biological products of putrefactive bacteria. The latter thrive in a certain moisture content of the nutritive substratum and at a temperature which is not too low. One necessary condition of good keeping property of wholesome meat is, therefore, a careful cooling immediately after slaughter, since the animal heat is the optimum temperature for the growth and multiplication of putrefactive bacteria. By the application of artificial agents—so-called preserving agents—it is possible to increase the normal keeping power of meat. The preserving agents are of a chemical and physical nature. The former are utilized more extensively in traffic in meat preparations, while the latter are more applicable to the traffic in unprepared meat.

It is doubtful whether it is possible to protect meat from decomposition by preservation in sterile air. The Argentine Government is said to have made an experiment in preserving fresh meat in sterile air in special rooms on transport vessels. The method of

Emmerich was also devised for the purpose of accomplishing sterile preservation.

This method consists in exenterating and cutting up food animals with instruments rendered aseptic by passing them through a flame. The natural casing of the meat, viz., the skin, fat, connective tissue, etc., are not removed. The surface of those portions of the meat not covered by the skin are sprinkled with glacial acetic acid and the pieces of meat to be preserved are finally packed in sawdust for the purpose of keeping them dry. The sawdust is saturated with common salt and heated and dried at a temperature of 180° C.

How long will meat keep under the ordinary conditions of preservation? Concerning this important question, accurate statements are found only in a work which has already become historical, namely, in Johann Peter Frank's "System einer vollständigen medizinischen Polizei." Mannheim: 1804. Frank makes the following statements: The learned contributions to the Braunschweigischen Anzeigen of 1773 contain a table on the length of time during which raw meat may be kept in the air without spoiling. The table gives the following data for the keeping power of meat of different origins:

	In Summer Days	*In Winter Days*
Deer	4	8
Wild boar	6	10
Hare	3	6
Pheasant	4	10
Black grouse	4	10
Wood grouse	6	14
Partridge	2	6–8
Cattle and hogs	3	6
Sheep	2	3
Calves and lambs	2	4
Turkeys and geese	4	8
Capons	3	6
Old roosters	3	6
Young roosters	2	4
Young pigeons	2	4

Naturally, as observed by Frank, this table would not hold true for all climates and all kinds of game.

"On sultry days and during thunder storms, meat may begin to decompose within one-half day."

1.—Chemical Preservatives.

The most common methods of preserving meat by means of chemical materials are those of salting and pickling. Moreover, the disinfecting agents, boric, salicylic and sulphurous acid, are used in the preservation of meat. Smoking is a combination method of preservation in which chemical materials and hot air act together.

With regard to the application and effectiveness, as well as the advantages and disadvantages of the various preserving agents, the following statements may be made :

(a) Salting and Pickling.

Application.—Common salt is used especially in the preservation of bacon sides and hams. Moreover, in America and Australia, beef is prepared for export by means of salt ("salt meat"). Salt is either rubbed into the pieces of meat in a dry condition (salting) or is applied in the form of a salt brine (pickling). For determining the salt content of the brine a so-called alkalimeter is employed, which is constructed according to the principle of Quevenne's hydrometer. The introduction of brine syringes marked an important step in advance in the field of preservation technique. These syringes end in a long, hollow needle which is introduced deeply into the connective tissue lying between the bones and muscles. By means of brine syringes it is possible, in a very short time, uniformly to impregnate large pieces of meat, especially hams, with salt water. This result would not be possible by simply laying the meat in salt brine. In large meat salting establishments, brine pumps, constructed on the principle of the force pump, are used. Ruppert and others recommend pickling in iron tanks from which the air has been exhausted and in which the pickling brine is allowed to penetrate the meat under pressure for a period of seven to eight hours. Pickling is thereby said to be more uniform than by the old method and much accelerated, so that the whole process of pickling hams requires only fourteen days, while by the old pickling method six to nine weeks were required. By means of a patent apparatus (rapid pickling apparatus "Meteor"), it is said that pickling takes place so rapidly that meat may be prepared ready for sale and cutting up within one to two days.

Pickling Through the Medium of the Circulatory System.—The Swedish investigator, Fjelstrup, recently attempted to introduce a method of pickling which utilizes the circulatory system for transporting pickling brine. The animals are killed by shooting, the hair is removed from hogs in the usual manner after death. The blood is still perfectly fluid under ordinary circumstances and this is a necessary condition for the success of the injection. The animal is then placed on its back in a trough table, so that the blood may run off completely. The thoracic cavity is opened by a long incision through the soft parts and by sawing through the sternum, and a canula is introduced through the left ventricle into the aorta and ligated. A pump is connected with the canula, by means of which the salt brine after the right side of the heart is opened, is forced in under a pressure equal to the normal aortic pressure. The salt brine thus forces the blood out through the right side of the heart and at the same time fills the blood system. The process requires from three to four minutes. After being cut up, allowed to cool and lying for a short time, the meat is ready for export or smoking. Cattle and sheep are injected with sterilized water or very weak brine immediately after death, in order to force out the blood.

This process is not new. J. P. Frank, in his "System," already referred to, states: "According to the statements of the Englishman Hales, an attempt has been made to inject with salt water the blood vessels of animals which have been killed by bleeding. This is done in order to preserve the meat longer. This method was first tested in Madagascar and is really the most rapid method of thoroughly saturating the meat."

Experiments with the new methods of preservation are not yet complete. According to Kühnau, the public objects to the utilization of injected meat in the form of fresh meat on the ground that it retains its red color in cooking.

Pickling With the Aid of Electricity.—The South American author Pinto claims that rapid pickling (within ten to twenty hours) may be brought about by passing an electric current through the meat while lying in the brine.

Effect.—The preserving action of brine depends upon the drying effect as a result of the extraction of water. Furthermore, chloride of sodium possesses slight disinfecting properties. The disinfecting action of salt consists in a general check upon the mul-

tiplication of micro-organisms, the prevention of the powerful proteolytic action of these organisms, even in a comparatively dilute solution, and the reduction of the chemical functions of certain organisms (Petterson).

Salt does not exhibit a pronounced checking effect upon micro-organisms except in solutions of from 20 to 23 per cent. In a concentration of 5 per cent. it hinders the multiplication of obligate anaërobes, but not that of facultative anaërobes and aërobes. Putrefactive bacteria are much more susceptible to the action of salt than cocci. In general the growth of bacilli is checked by a 10 per cent. solution of salt. Some of them, however, endure a concentration of 12 per cent. and occasionally one of 15 per cent. in pure cultures in bouillon. The majority of cocci thrive even in a solution containing 15 per cent. of salt.

Salt is well adapted for use in the preservation of the meat of healthy animals. The action of salt upon pathogenic bacteria in meat, however, has been considerably overestimated, although J. P. Frank, at the close of the 18th century, stated: "Brine on meat which is fundamentally spoiled is nothing more than an unwholesome broth, and if any one believes that salt can extract the poison from suspicious meat in the manner in which it dissolves the aqueous parts thereof, such a person would allow his imagination to influence his most important business dealings for very slight reasons." Frank rightly characterizes the pickling of the meat of diseased animals as "painting with a sort of health varnish," and called attention to the fact that pickling has no other effect upon the meat of diseased animals than to preserve it from total decomposition in the same manner as it preserves healthy meat. This empirical demonstration of the great sanitarian of the 18th century has been confirmed from a scientific standpoint by recent exact experiments. According to the experiments of Forster, pathogenic staphylococci, the streptococcus of erysipelas and the bacilli of swine erysipelas, remain alive for weeks and months when pure cultures of these micro-organisms are covered with salt. Tubercle bacilli in cultures treated in the same manner proved virulent after two months. Pieces of tuberculous organs finely minced also proved to be virulent after lying in salt brine for eighteen days. Anthrax bacilli were destroyed in from eighteen to twenty-four hours. Anthrax cultures, however, containing spores, retained their virulence for months, despite treatment with salt. Salting the meat of diseased animals has, therefore, by no means the high value which is commonly ascribed to this method of preservation.

The effect of salt manifests itself in the meat by a decolorization of the musculature. In order to prevent this result, it is customary to add saltpeter to the salt brine.* According to Glage, however, the persistence of the red color of meat is not due to saltpeter, but to the effect of the nitrites and perhaps nitric oxide, which are formed from the saltpeter in the brine. In cooked meat products, the addition of a small quantity of nitre to the pickling salt is a sure means of producing the red color. Also in the case of raw meat products it is not the saltpeter, but one of its decomposition products (nitric oxide?) which preserves the redness of the coloring matter of the muscle. Glage determined, furthermore, that in raw meat products, in addition to saltpeter and cane sugar, di-phosphate of soda, potash and borax have the effect of gradually producing a red color.

Composition of Ordinary Brine.—Sixteen parts of salt are mixed with one-half part saltpeter and 1.5 to 2 parts of sugar. For each 100 kg. of meat, 5 kg. of this mixture is used, or 4,350 gm. of salt, 150 gm. of saltpeter and 500 gm. of sugar. The sugar is added to the meat on account of its marked action in preventing putrefaction (impoverishment of the nutrient medium for putrefactive bacteria). On the other hand, the addition of sugar may cause a slimy fermentation of the brine, which, however, is said to be without effect upon the character of the pickling material.

Special Pickling Methods.—In America, the so-called dry pickled beef is prepared in the following manner:

A 20 per cent. salt brine is prepared with the addition of saltpeter and sugar. The meat is thus pickled in a moist condition. Before it is shipped the meat is dried by means of special machines and is sprinkled with borax. The addition of borax is said to amount to from 1 to 2 per cent.† After the meat is sprinkled with borax, it is pressed by machine power.

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* "Stabil," which is recommended by the preservative manufacturer Adamczyk for the preservation of sausage for long keeping, contains 79 per cent. of saltpeter (Polenske).

† According to an analysis made in Germany, the content of boric acid is much greater. Thus, in Dresden, 3.87 per cent. boric acid was demonstrated in American dry pickled beef. Amthor found in American beef 70.37 per cent. water and 7.61 per cent. mineral substances which consisted of 68.5 per cent. salt and 19.5 per cent. borax. In 51 samples of American dry pickled meat (partly pork and partly beef) Polenske demonstrated boric acid in every case. Nineteen samples contained from 1 to 2 per cent.; 13, 2 to 3 per cent., and 1 sample, 3.36

The Chicago firm of Nelson, Morris & Co. declares that it pickles meat only by means of a salt brine and that at least sixty days are occupied with the process. The meat is then allowed to hang eight to ten days more before it is ready for export.

American pickled tongues are slightly salted, but, like the greater part of American dry pickled beef, contain the forbidden boric acid. The tongues are washed in water, thoroughly cleaned and dried. They are then rubbed with a mixture of 50 kg. coarse dry salt, 350 gm. of saltpeter and 750 gm. of borax, or with the same weight of boric acid, and placed in tight oak casks. Usually there is such an abundant production of brine that the subsequent addition of artificial brine is unnecessary. The casks are hermetically sealed after three or four days.

Demonstration of Pickling.—Probably under the erroneous supposition that any injurious properties which are contained in the meat are destroyed by the pickling process, the introduction of pickled meat was favored as compared with that of fresh meat. For this reason the distinction between pickled meat and fresh meat is of practical value. As shown by Glage, pickled meat has an alkaline reaction, tastes salty and is darker red and firmer than fresh meat and exhibits a lacquer-like cut surface, while the cut surface of fresh meat shows grooves and channels on account of the unequal retraction of the muscle fibers. For the certain detection of pickling, Glage recommends, in the place of the simple silver nitrate solution proposed by the author, a solution of silver nitrate partly neutralized by ammonia and possessing the following composition:

Argent. nitric, 2.
Aqua destill., 100.
Mf. sol.
Adde exactissime
Liquor. Ammonii caustic. q. s.
ad præcipit. et perfect. resolut.
Argent. nitr.; deinde
Liquor. Ammonii caustic. volumetric 40 cc.
Aq. destill. q. s. ad 200 cc.
M. D. in vitro flav.
Sig. Reagent for the differentiation of salt and fresh meat; 10 cc. for each sample of 1 gm.

The reagent is to be preserved in well-stoppered yellow glass bottles. For making the test, 10 gm. of the reagent is poured into

per cent. The pieces of meat were surrounded by a gray layer 1 cm. thick. The inside of the beef possessed a deeper red color than fresh meat. The water content of the dry pickled beef ranged between 65 and 69 per cent.

a glass bottle with a wide neck and a ground glass stopper. A piece of meat, as free from fat as possible, about the size of a nut (1 gm.) is taken from the interior of the piece of meat to be tested and thrown into the reagent. The piece of meat should not be comminuted. If one observes a white precipitation of chlorid of silver which by daylight rapidly becomes violet or black, but by lamplight slowly, or not at all, the meat has been pickled. Fresh meat produces only an albuminous cloudiness which does not become discolored. Fresh meat also retains its red color, while pickled meat becomes coated with chlorid of silver on the surface.

Effect of Pickling on the Composition of the Meat.—As a result of pickling, meat suffers a loss of nutritive material. Polenske pickled meat in a solution of 1½ kg. salt, 15 gm. saltpeter, and 120 gm. of sugar in 6 kg. of water, and found that the weight of the pickled meat was considerably diminished as a result of the mutual exchange between the meat juice and brine. The maximum of increase of weight was observed within three weeks and amounted to 12 per cent. of the original weight. By the action of the brine, however, the following quantities of materials were extracted from the meat:

	Nitrogen	*Anhydrous Phosphoric acid*
	Per cent.	*Per cent.*
After three weeks' pickling	7.77	34.72
After six months' pickling	{ 10.08 { 13.78	{ 54.46 { 54.60

Polenske was unable to demonstrate directly the loss of any potash salts. On the other hand, the high content of phosphoric acid in the brine showed that the potash salts had also been extracted to a large extent.

According to an analysis of Voit, the nutritive value of meat appeared not to have been greatly diminished by pickling. This investigation, however, was made on meat which had been pickling only 14 days. At this time 1,000 gm. of fresh meat had absorbed 43 gm. of salt and had given up 79.9 gm. of water, 4.8 gm. organic materials, 2.4 gm. albumen, 2.5 gm. extractives and 0.4 gm. phosphoric acid. Expressed in the form of a percentage, the loss amounted to 10.4 of water, 2.1 organic materials, 1.1 albumen, 13.5 extractives and 8.5 of phosphoric acid.

Experiments conducted by Nothwang, however, confirmed the result which had been obtained by Polenske. Nothwang found the

extraction of phosphoric acid, and especially of extractives, to be so considerable that pickled meat must be regarded as actually an inferior product. Nothwang demonstrated that pickling causes a greater loss of material than mere salting. In pickling, 2.14 per cent. of the protein and 50.1 per cent. of the phosphoric acid was lost, while meat which had lain in salt for the same length of time—the maximum of extraction of materials was reached during the first two weeks—lost only 1.3 per cent. of the protein, 39 per cent. of the extractives and 33 per cent. of the phosphoric acid.

Judgment of the Saltpeter Content of Pickled Meat.—Lehmann emphasizes the fact that saltpeter is a powerful poison for man. Five gm. may cause decided illness and 8 gm. (more often 15 to 25 gm. are required) prove fatal. Nothing is known concerning saltpeter poisoning from the consumption of meat. The question of the hygienic judgment of saltpeter appears still to require a more thorough examination.

Nothwang investigated the saltpeter content of various meat products and obtained the following data: Dry pickled meat products do not always contain saltpeter, but often contain only common salt. The greatest amount of saltpeter was found in red hams and the so-called country hams, but always in harmless quantities (0.197 to .328 per cent.). Even if an adult person should eat 200 to 300 gm. of such meat, he would receive only 0.66 to .99 gm.—quite a harmless dose.

The salt content of dry pickled meat products varies between 3.42 per cent. (boiled hams), 5 per cent. (raw hams) and 8.7 per cent. (Kassel spare ribs).

In a series of experiments it was found that meat pickled in brine absorbed a constantly increasing quantity of salt, while the saltpeter content became less after a short time (eight days). Nothwang ascribes this disappearance of the saltpeter, which, however, did not always occur, to reduction processes in the meat (formation of nitrous acid). For the rest, the content of salt and saltpeter in meat is dependent, according to Nothwang, upon the concentration of the solution which is used, upon the length of the period of application, upon the transformation of saltpeter into ammonia, the pressure brought to bear upon the meat, and perhaps also upon the temperature and certainly upon the size of the pieces of meat which are subjected to the pickling process.

(b) Smoking.

Different Methods of Smoking.—Since ancient times the preserving action of smoke has been utilized for increasing the keeping powers of meat and meat products (smoked meat).

In practice, distinction is made between two kinds of smoking: slow and rapid or so-called hot smoking. The greater part of meat products is smoked slowly, that is, for days at a temperature of about 25° C. Certain products, however, like knackwurst, also all fish, are either exposed to smoke for several hours at a temperature of 70° C. and thereupon for a shorter time at a temperature of 100° C. or more, or they are immediately exposed to smoke at a temperature of 100° C. Discontinuous smoking, in which the smoking process is maintained only during the day, is highly unsatisfactory. It is thus brought about, as shown by Senkpiehl, that in winter the pieces of meat are frozen during the night and thawed out again during the day, as a result of smoking. There can be no doubt that the process of decomposition is favored by the repeated freezing and thawing of the meat.

Materials for Producing Smoke.—Only wood smoke is utilized for smoking meat. Juniper bushes, beech chips with juniper berries, tanbark with mahogany chips and other waste material from hard wood furnish very good smoke. Fir chips are not desirable, since they unfavorably affect the taste of the smoked products.

Preservative Effect of Smoking.—The action of smoke consists in extracting water as a result of the high temperature of the smoke and in the influence of the disinfecting materials contained in the smoke; for example, creosote, empyreumatic oils and carbolic acid.* Serafini and Ungaro mention the higher tar-like substances as active constituents of smoke. The effect of these substances is increased by the disinfecting action of carbonic acid.

Beu examined smoked products from the market, and animal food materials which he smoked. During this investigation it was found that among the meat products which are found on the market and which had been smoked slowly, bacon was the only one which

* It thus appears that simple moistening of meat products with pyroligneous acid, which has been a common practice for many years, as a substitute for smoking, can not produce the preserving effect of smoke.

was absolutely free from bacteria in its interior. Country mettwurst exhibited some colonies of *Micrococcus candicans*. Hamburg smoked meat which had been pickled for from three to four weeks, then slowly smoked for five days, showed several colonies of white staphylococci. In a piece of the same meat products which had been smoked for three days, numerous bacteria were found, among which a species of proteus was observed. Fish smoked at a high temperature were either free from bacteria or showed but few colonies which did not liquefy gelatin. Numerous putrefactive bacteria, among them *Proteus vulgaris*, were found in the knackwurst which had been smoked at a high temperature.

The experiments which Beu instituted for determining the influence of a gradual smoking at a temperature of 22° to 25° C. yielded the following results: Pickled lean pork which before smoking contained large numbers of putrefactive bacteria was absolutely free from bacteria after a six-day period of smoking. Similarly, bacon became free from bacteria after subjection to smoke for seven days. A piece of unsalted pork, on the other hand, began to decompose in spite of smoking, and in knackwurst with which Beu experimented he was unable to observe any considerable effect upon the bacterial content despite long continued smoking. The marked influence of a previous extraction of water by salting upon the preservative effect of the smoke thus becomes apparent.

The disinfectant influence of smoke, whether by the slow or by the hot process, can not be denied. On the other hand, putrefactive bacteria are destroyed with difficulty or not at all in meat products which contain much water and which have not been previously dehydrated by pickling.

Effect of Smoke Upon Pathogenic Bacteria.—Serafini and Ungaro demonstrated that smoke exercises a very energetic bactericide action upon pure cultures of bacteria. The effect is observed in the case of the anthrax bacillus and staphylococcus after not more than $2\frac{1}{2}$ hours; in the case of the hay bacillus after $3\frac{1}{2}$ hours, and in the case of anthrax spores after 18 hours. Palozzi found that staphylococci, diphtheria bacilli and anthrax bacilli were killed in 1 hour and anthrax spores in 8 hours, and the tubercle bacillus in 2 hours. In experiments with infected meat, however (pieces of guinea pigs infected with anthrax), Serafini and Ungaro found that the process of smoking did not appear to act so energetically upon the bacteria contained in the meat as upon pure cul-

tures. Smoke penetrates with difficulty into the interior of the meat, chiefly for the reason that under the influence of the smoking process a layer of coagulated albumen is formed upon the surface of the pieces of meat. Serafini and Ungaro came to the conclusion that smoking in and of itself had the effect of checking the growth of bacteria as a result of desiccation, but that it did not destroy the pathogenic bacteria which might be present in the meat.

(c) Preservation with Boric, Sulphurous and Salicylic Acids.

Boric, sulphurous and salicylic acids exert a more decided influence in checking the growth of bacteria than does salt. It was, therefore, probable from the first that the keeping property of the meat could be considerably increased by means of these agents. Against the use of these chemical substances, however, it may be objected that they are not indifferent for the human organism, especially for the sick or convalescent, and that furthermore the consumer in buying meat and meat products assumes that foreign materials like boric, sulphurous and salicylic acids are not contained in those products.*

1.—Boric Acid.

Application.—Boric acid is used either alone as a powder and in an aqueous solution, or together with other preserving agents. In the powdered form boric acid is dusted upon the livers after a previous cutting into strips, and upon American dry pickled beef (page 803). Otherwise boric acid is used only in a fluid form, that is, in solution with water. Thus, in America, Denmark and Russia, the practice prevails to a large extent of injecting livers with a solution of boric acid ("Hamburg" or "injected livers"). Boric acid is a good reagent for checking putrefaction. As shown by Petterson, however, it does not completely prevent decomposition of

* For this reason the Swiss Government has prohibited the use of chemical agents in preserving meat and meat products, with the exception of salt and saltpeter. Likewise, the German Federal Council has forbidden through a decree of February 16, 1902, which went into effect October 1, 1902, the use, for meat preserving purposes, of boric acid and its salts, formaldehyde, hydroxids and carbonates of alkalies and alkaline earths, sulphurous acids and their salts, as well as the salts of hyposulphurous acid, hydrofluoric acid and its salts, salicylic acid and its combinations, and, finally, the salts of hydrochloric acid.

meat. Borax, on the other hand, is, according to Petterson, a very effective agent in checking the growth of bacteria when used in combination with salt.

Trade Preparations Which Contain Boric Acid.—According to Venzko and Schorer, the following preparations should be classed under this head :

1–3. *Saline salt II., Barmenit,* and "*strong preserving salt,*" consisting of equal parts of salt and boric acid.

4–5. *Boroglycin, Rohkrämer's preserving salt* (95 per cent. boric acid and 5 per cent. sugar).

6. *Eckhart's preserving salt* (60 per cent. salt, 40 per cent. boric acid).

7. *Ziffer's preserving powder* (30 per cent. salt, 1.5 per cent. Glauber salts and 68.5 per cent. boric acid).

8. *Sanität,* a brine preserving fluid containing in each liter 45 gm. boric acid, 8.5 gm. salt, 2.5 gm. ferrous gypsum and Glauber salts.

9. *Three-fold preserving salt* (93.5 per cent. boric acid, 5 per cent. saltpeter and 1.5 per cent. salt and Glauber salts).

10. *Simple preserving salt* (48 per cent. saltpeter, 50 per cent. boric acid, 1.5 salt, and 0.5 Glauber salts).

11. *Ziffer's preserving salt* (30 per cent. boric acid, 35 per cent. saltpeter, 33 per cent. salt and 2 per cent. Glauber salt).

12. *Oppermann's cervelatwurst salt* (77.5 per cent. salt, 13.5 per cent. saltpeter, 8.7 per cent. borates and 0.3 per cent. organic substances).

Furthermore, according to Polenske, the following should be mentioned in this connection :

13. *Dresel's preserving or pickling salt* (80 per cent. salt, 12 per cent. saltpeter, 8 per cent. borax).

14. *Preserving salt* for covering and packing American hams after removal from the pickling water (84 per cent. borax, 3 per cent. salt, 13 per cent. water).

15. *Stare's "sausage salt," Stare's "conservator," Stare's "sanität,"* for pickling, containing as their chief constituent boric acid (about 60 per cent.) and also saltpeter (12 to 14 per cent.), cane sugar (4 to 8 per cent.) and sodium salicylate (7.6 per cent.). The conservator, which Stare claims will keep meat dry and fresh, was found to contain 32.3 per cent. borax and 42 per cent. salt.

16. *Stern's three-fold preserving salt* (80 per cent. borax, 17 per cent. boric acid and 3 per cent. salt).

17. Delventhal and Künzel's *Berlinit*, concentrated (7.46 per cent. salt, 9.8 per cent. boric acid, 45.75 per cent. borax, with 36.8 per cent. water of crystallization). Berlinit for pickling (45.92 per cent. salt, 32.2 per cent. saltpeter, 19.16 per cent. boric acid, 2.28 per cent. water).

The following preservative agents also contain borax: viz., China preserving powder, Minerva (contains also sodium sulphate), Ohrtmann's Australian salt, Magdeburg preserving salt, Heydrich & Co.'s preserving salt.

Experience Concerning the Preservative Effect of Boric Acid.—According to a statement of Lehmann, a 1 per cent. solution of boric acid has the effect of keeping meat for four to seven days longer than normal. Schiff highly recommends the method of Herzen, according to which crude boric acid is dissolved in water with the addition of borax and a little salt and saltpeter, and poured upon the meat. The meat is then said to retain a perfectly fresh appearance. Roosen recommends boric acid in combination with tartaric acid and salt (about 3 parts of the mixture to 97 parts of water) for the preservation of fresh meat, and especially of salt water fish. Roosen claims for his method that it extends the market for salt water fish in the interior. The fish keep very well in casks. When, however, the fish are removed from the casks, they keep but a few days in an undecomposed condition.

Demonstration of Boric Acid in Meat.—According to Kämmerer, one may employ either the flame test or curcuma paper.

For making the flame test, 10 gm. of the suspected meat are saturated with a soda solution and incinerated in a platinum or porcelain vessel. The incinerated mass is carefully neutralized with dilute sulphuric acid (1 : 10), 5 cc. of concentrated sulphuric acid, and 5 cc. of methyl alcohol are then added and the mixture is ignited. In the presence of boric acid, the flame exhibits the familiar emerald green color.

Likewise, in making a test with curcuma paper, the mixture is neutralized with sulphuric acid and the curcuma paper is dipped into the solution. If boric acid is present, the curcuma paper exhibits a brown or red color after drying and then moistening with water. If the paper is then sprinkled with 10 to 12 per cent. potash lye, a green coloration appears if boric acid is present.

The following method is prescribed, for demonstrating boric

acid, by a decree of the Swiss Agricultural Department concerning the veterinary service along the frontier, December 5, 1898 :

A piece of meat not smaller than a walnut, from which most of the fat has been removed, is finely minced and shaken up in a wide test tube together with 20 to 30 cc. of water and a few drops of hydrochloric acid. It is then heated to the boiling point, during which part of the boric acid which is present passes over into the solution. A strip of curcuma paper is then dipped into the solution. If the paper appears red after drying in the air, borax was present in the sample of meat.

Häfelin recommends the following method for the quantitative demonstration of boric acid in meat and sausages : 10 gm. of meat or sausage, as free as possible from fat, is finely minced and boiled for about one minute in a wide test tube together with a mixture of 2 cc. glycerine, 4 cc. alcohol, 4 cc. of water and a few drops of hydrochloric acid (enough to give an acid reaction). The mixture is then filtered through a moist folded filter if fat is present. It is then tested with curcuma paper of known sensitiveness. The paper is dried by rapidly passing over the flame of a Bunsen burner. If boric acid is present, a cherry-red or brown color appears, which must persist when the paper is sprinkled with water, but which passes into a bluish black when sprinkled with ammonia. Häfelin calls attention to the fact that in case of the combinations mentioned by the Imperial Health Office, the flame reaction may lead to erroneous conclusions, since the CH_3Cl or C_2H_5Cl which is formed under certain circumstances, burns with a green color.

The Effect of Boric Acid on Man.—Liebreich is of the opinion that fish treated with boric acid according to Roosen's method can not exercise any injurious effect upon health. It is maintained that man can consume two to four grams of boric acid daily without any bad consequences. However, fish preserved according to Roosen's method contain only two grams of boric acid per kilogram, three-fourths of which may pass over into the water in boiling. Accordingly, so small a quantity remains in the meat of the fish that no injurious effect need be feared from daily consumption of the material.

In opposition to the assumption of Liebreich, Amthor showed that the quantities of borax demonstrated by him in American dry pickled meat (page 803) are not completely removed even by washing in water for eighteen hours. Heinze obtained the same results. Pieces of American dry pickled meat containing 1.16 per cent.

boric acid were washed under tap water. They were then soaked in water for two and one-half to twelve hours and boiled for three and one-half hours. Heinze found that the meat was not completely free from boric acid even after soaking for twelve hours, but still contained 0.93 per cent. of boric acid, while 0.28 per cent. was found in the bouillon.

Emmerich considers the use of boric acid as a preservative as unallowable, since, according to his experiments, a dog was made very sick by eating two grams and a large rabbit was killed with four grams. On the basis of these experiments and other experience, the Association of Bavarian Representatives of Applied Chemistry declared that "the use of boric acid as an addition to foods and condiments is not an indifferent matter from a sanitary standpoint, according to the present knowledge of the subject."

Likewise, the physiologist, Halliburton, and the sanitarian, Gruber, have argued against the admission of borax preparations and similar materials as preservatives. Moreover, Annett and Chittenden, as well as Gies, have experimentally demonstrated the harmful effect of borax and boric acid. Chittenden and Gies demonstrated that boric acid and borax produce indisposition and vomiting in experimental animals when the dose amounted to 1.5 to 2 per cent. of the daily ration.

In accordance with this view, the Swiss Government has forbidden the importation of American dry pickled meat and has also issued the following decree of March 19, 1897, concerning the introduction and sale of meat:

"The use of borax preparations, salicylic acid, formalin, combinations of sulphurous acid and other chemical agents for the preservation of meat and meat products, with the exception of salt and saltpeter, is forbidden for all meat intended for sale and subject to inspection."

2.—Sulphurous Acid.

Application.—For natural reasons, gaseous sulphurous acid is not used in the technique of meat preservation. On the other hand, the use of acid calcium sulphite and acid sodium and potassium sulphite is a common practice in the preservation of meat. As shown by Fischer in his Yearbooks, as much as 50 per cent. of the inspected samples of minced meat in Breslau have been treated with the salts of sulphurous acid.

Trade Preparations Which Contain Sulphurous Acid or Its Salts.—Venzko and Schorer have demonstrated sulphurous acid or its salts in the following preservatives which are found on the market:

1. *Meat preserve*, consisting of an aqueous solution of calcium sulphite. One liter of the fluid contains 68 grams sulphurous acid and 18.5 grams lime.

2. *Best Australian and New Zealand meat preserve* (powder, consisting of sodium sulphite, 23 per cent.; salt, 40 per cent.; Glauber salt, 37 per cent.). The fluid which has been placed on the market under the same name consists of acid calcium sulphite (77 grams of sulphurous acid and 22.5 grams lime per liter).

3. *Royal Australian meat preserve*, consisting of sodium sulphite, 19 per cent.; Glauber salt, 79 per cent.; common salt, 2 per cent.

4. *Sozolith*, consisting of 80 per cent. Glauber salt and 20 per cent. sodium sulphite.

5. *Double concentrated sodium sulphite* (fluid), containing 254 grams sodium bisulphite and 71 grams Glauber salt, per liter.

6. *Meat preserve crystal* (powder), consisting of 53 per cent. sodium sulphite, 6 per cent. salt and 41 per cent. Glauber salt.

7. *Meat preserving crystal excelsior* (powder), consisting of crystalline sodium sulphite, 85 per cent., and Glauber salt, 15 per cent.

8. *Carnat* (powder), consisting of 43 per cent. salt, 25 per cent. sodium sulphite, 27 per cent. Glauber salt, 5 per cent. sugar.

9. *Meat conserve fluid*, containing 38.7 grams sulphurous acid and 16.2 grams lime per liter. It, accordingly, consists of bisulphide acid calcium sulphite.

According to analyses made by Polenske in the Imperial Health Office, the following preservatives also belong to this group:

10. *Odorless meat preserve fluid*, consisting of 22 parts common salt, 73 parts Glauber salt, 171 parts sodium sulphite, 34 parts sulphurous acid and 0.15 parts vanillin per liter of water.

11. *Meat preserve powder*, consisting of sodium hyposulphite, which is in large part oxidized to sodium sulphite.

12. *Newest meat preserve powder*, consisting of sodium hyposulphite, one-half of which is oxidized into sodium sulphate.

13. *Chromosot*, consisting of coloring material which does not belong to the analin dyes, and also sodium sulphite, sodium sulphate and albumen.

14. *Adamczyk's "Probat"* (47.5 per cent. sodium sulphite, 11 per cent. sodium sulphate, 10.5 per cent. common salt, 4.5 per cent. sugar).

15. *Preserving salt of Langlein & Co.* (80 per cent. crystallized sodium sulphite, 20 per cent. crystallized sodium sulphate, with a small percentage of soda).

Finally, salts of sulphurous acid are contained in "treuenit," manufactured by the druggist Wolf in Treuen; "Universal Preserving Fluid," made by Druggists Volz and Oehme; Stuttgart Conserve Salt, and in "German Meat Water."

In an extensive series of analyses made in Nürnberg, 29 per cent. of the samples examined contained the salts of sulphurous acid, and in a similar test of samples in Dresden 52 per cent. contained these salts.

Preservative Effect.—According to Baierlacher, sulphurous acid operates most vigorously on yeasts. It also prevents the formation of mold and delays the process of decomposition, without, however, preventing it entirely. Schmidt-Mülheim recommended calcium sulphite on the basis of his experiments for preserving raw minced meat. If from 30 to 40 cc. of a saturated solution is poured upon 10 kg. of minced raw beef, the penetrating odor of sulphurous acid rapidly disappears, for the reason that it is oxidized in the meat. It is claimed also that in boiling and roasting such meat, no odor of sulphurous acid is apparent. The keeping property of the meat is said to be greatly increased. After exposure to the air for a long time the meat possesses the appearance of a perfectly fresh color, and even after standing for days at a living temperature exhibits no evidence of decomposition. On the other hand, the development of molds was not prevented in all cases.

These statements were subsequently found to be not strictly correct. It appears that sulphurous acid is a good preservative for the muscle pigment, but not for the meat itself.

Detection of the Addition of Sulphurous Acid and its Salts.—Under a microscopic examination of meat which has been treated with sodium or calcium sulphite, the presence of Glauber salt or gypsum crystals becomes manifest in consequence of the partial oxidation of sulphurous acid in the meat. Kämmerer recommends a method of demonstration by means of potassium iodate paper.

Samples of meat are laid on potassium iodate paper and moistened with sulphuric acid free from nitric oxide (1 : 8). In the presence even of small quantities of sulphurous acid, a pronounced blue color immediately appears in the paper. If the meat has not been

treated with sulphurous acid, there is either none or only a slight blue color, and that not until some time after. The latter case occurs when the meat is not quite fresh. The color change which appears in such cases, however, can scarcely be mistaken for the instantaneous blue coloration caused by the presence of sulphites.

Kämmerer notes, furthermore, that many samples treated only with dilute sulphuric acid give off immediately the odor of sulphurous acid.

Salted meat can not be tested with potassium iodate paper and sulphuric acid, since the hydrochloric acid which is set free after the addition of sulphuric acid is immediately decomposed in contact with the iodic acid. Similarly, meat products treated with saltpeter can not be tested according to the method of Kämmerer, since in this case the nitrites immediately produce a pronounced blue color.

Judgment of the Addition of Sulphurous Acid to Meat.—Since each pound of meat requires only one-fifth gram of sulphurous acid and one-fifteenth gram of lime, there can not exist, according to Schmidt, any possibility of an injurious effect from so slight an addition of calcium sulphite to meat. Nevertheless, the addition of "meat preserve" to minced or chipped meat should be forbidden; for, in the first place, such an addition is not expected by the consumers. In buying minced meat in ordinary trade, it is assumed that it is pure meat without the addition of chemical agents. In the second place, the amount of the addition can not be controlled in individual cases, and, consequently, in a careless application it may occur that poisonous quantities of the preservative are added to the meat. In samples of minced meat, taken under police supervision, 0.5, .85, and 1.4 per cent. of the salts of sulphurous acid were frequently demonstrated, and in one case (Köln) as much as 2.24 per cent. In some cases Kämmerer found minced meat thickly covered with preserving salt, ostensibly for the purpose of keeping flies away from the meat. Moreover, even in the case of the addition of ordinary quantities, injurious amounts may be present in certain parts as a result of an unequal distribution. It is thus a fact of great importance that the salts of sulphurous acid do not commonly hinder the process of decomposition, but merely obscure it (compare the observation of Möbius). It should also be remembered that the addition in question is calculated to deceive the buyer concerning the true character of the meat, for this addition gives inferior meat a

better appearance, renders possible a fraudulent addition of water, and also makes it possible to sell old minced meat as fresh material. Moreover, it is not at all desirable that minced meat should be capable of preservation for a long time. Minced meat should be prepared only for immediate use, since, in contrast with meat which is not minced, it possesses a striking tendency to decomposition (compare "Minced Meat Poisoning").

Finally, attention should be called to the fact that the use of preservatives which contain sulphurous acid or its salts is not to the interest of tradesmen. For, according to Schorer, sulphurous acid frequently becomes changed into sulphuretted hydrogen and the meat thus acquires the familiar odor of rotten eggs and becomes absolutely unsaleable.

According to a report of the Saxon District Veterinarian, Möbius, several persons, adults and children, became ill after eating minced meat sprinkled with meat preserve. The symptoms were loss of appetite, vomiting, internal pains and diarrhea. A microscopic examination of the minced meat in question showed that the transverse striation of the musculature was still retained. Bacteria, micrococci, triple phosphate and gypsum crystals were present. The presence of triple phosphate crystals, demonstrated by Möbius in the poisonous minced meat, shows that decomposition may take place in meat in spite of the preserving fluid.

L. Pfeiffer, in Munich, collected the statements contained in literature concerning the toxic effect of sulphurous acid upon man (compare Lehmann). These statements varied greatly. Polli found 8 to 12 grams of the salts of the sulphurous acid to be harmless for adults, and other authors found 1.8 grams per day of these salts to be without effect upon children, while, according to Bernatzik and Braun, doses of even one gram magnesium sulphite with 0.3 gram sulphurous acid were not well endured by women in childbirth (vomiting and diarrhea). On the other hand, one-third of these patients who received 3.75 grams sodium sulphite (with 2.28 grams SO_2) and two-thirds of those who received 3.75 grams potassium sulphite (with 1.98 grams SO_2), showed no bad effects of the treatment. The other women showed digestive disturbances.

Kionka found that a young dog which during a period of five days had received 90 grams of the preserving salt of Heydrich & Co. died, and also that two other dogs which during a period of 44 days had been fed 711 grams of the preserving salt together with meat did not increase in weight, despite the fact that their rations were large, but showed, temporarily, diarrhea and vomition. The

dogs were killed and in both cases hemorrhages were found in the lungs and in one case an intensive hemorrhagic nephritis. Similar alterations were observed in two dogs which during a period of about nine weeks received only as much preserving salt together with meat as should be added to the meat according to directions (12 grams of the salt for each 5 kg. of meat). To be sure, the two last-mentioned experimental animals received very large quantities of meat daily (300 to 1,000 grams). The animals remained well during the experiment and increased considerably in weight.

Kionka, on the basis of his experiments, came to the conclusion that the use of the salts of sulphurous acid as a preservative should be absolutely forbidden on account of their injurious properties. He condemns the procedure of the Chemist Bischoff, who gave an opinion to the effect that the preserving salts in question were not harmful to health when used in the quantities recommended.

The Chemists Bischoff and Lebbin believed themselves justified in advocating the addition of sulphites (not more than one or two grams per kilogram of meat), on the ground that such addition was harmless. Liebreich also declared in favor of admitting sulphites as preservatives, since, according to his view, they did not cause any harm to the purchaser.

The Imperial Health Office issued the following statement concerning the necessity alleged by butchers for the addition of sulphites to minced meat and concerning their sanitary importance :

1. By preserving proper cleanliness, minced meat may be prepared from freshly slaughtered meat, without the use of chemical preservatives, so successfully that when preserved at a low temperature it will retain its normal color for more than twelve hours.

2. The addition of sulphites and preservatives which contain such salts is calculated to improve the natural color of the meat, but not the meat itself, and to make the meat keep longer. The appearance of a better quality may thus be given to minced meat.

3. The continued consumption of minced meat which has been treated with sulphites may injure human health, especially in the case of sick and weakly individuals.

Among the materials which serve as a foundation for these propositions, the following statements are worthy of reproduction :

"The consumption of minced meat which has been prepared with the aid of sulphites is by no means an indifferent matter from a sanitary standpoint. It is true that upon the wrappers of several of these preservatives opinions of experts are printed wherein certain quantities of the preservatives are stated to be absolutely harmless, and butchers on the basis of these opinions are accustomed to

utilize sulphites without special care. They are not able to understand that these opinions concerning the harmlessness of the preservatives are given by chemists or men whose technical training lies in other fields than that of medicine and hygiene.

"The preserving materials which contain sulphites possess a pronounced toxic effect, which consists of a local irritation of the gastric mucous membrane and in an injury to the blood system. The consumption of no more than 0.5 gm. of sodium sulphite is accompanied by a general indisposition and digestive disturbances. Smaller doses of the salt would probably be without effect upon healthy persons, but even if a certain small dose in the regular diet should be shown to be harmless for healthy individuals, we must still have some hesitation in admitting to the market minced meat treated with this quantity; for, as is well known, the use of minced and chipped meat is frequently recommended by physicians for sick and convalescing persons; or, in other words, individuals whose digestive organs are in a weakened condition. For such individuals however, the consumption of meat treated even with a minute quantity of sulphites, is undoubtedly accompanied by bad consequences. In this connection, it should also be remembered that the distribution of the preservative in the meat mass when carelessly applied may be irregular, so that comparatively large quantities may be found in certain parts of the meat."

3.—Salicylic Acid.

The power of salicylic acid in checking the development of bacteria is well known. On account of its slight solubility in water and its disagreeable taste, however, salicylic acid is less adapted for use in the preservation of meat than, as emphasized by Lehmann, for alcoholic, strongly flavored substances, such as beer. Nevertheless, salicylic acid is used in the preservation of fish (salmon).

Toxic Effect of Salicylic Acid.—Kolbe for a period of nine months took one gram of salicylic acid daily in various drinks without the slightest harm; and Lehmann persuaded two Munich workmen to take one-half gram each of salicylic acid in one-half liter of beer for seventy-five and ninety-one days, respectively, without noting the slightest trace of an effect upon their condition. Toxic symptoms were not observed until the dose reached five grams. The Paris Academy of Sciences, however, would not admit the addition of small doses of salicylic acid to food materials, since even small

doses repeated daily for a long period produced disturbances of health in old individuals and in persons affected with cardiac and digestive troubles.

Other Chemical Preservatives.—Under the name "salufer," a silicate of fluorin (fluorin sodium silicate) has been patented in England and is claimed to possess remarkable antizymotic properties. A saturated solution containing 0.61 per cent. of this body has a greater antiseptic effect, according to Thomson, than a 1 per cent. aqueous solution of corrosive sublimate. Minced meat is said to remain in an undecomposed condition for a long period under the influence of this tasteless, odorless and non-poisonous body.

Another method which has been patented in England consists of dipping meat in ammonium acetate and then allowing it to dry in the air. The meat is said to keep well when treated in this manner. Upon boiling or roasting, the ammonium acetate disappears completely and no trace of the preservative is noticed in eating the meat.

Furthermore, potassium permanganate (under the name antigrisein) has been recommended for preserving meat.

Formalin (40 per cent. aqueous solution of formaldehyde) has recently been recommeded as possessing a considerable preserving power. Its use, however, is somewhat questionable, since aldehyde does not belong to the indifferent bodies. Against this view, held by Halliburton,* Fernbach and other well-known writers, Windisch claims that the use of formaldehyde as a preservative is unobjectionable, for the reason that formaldehyde is also contained in smoke and is perhaps a more active constituent than creosote. Formaldehyde can actually be demonstrated in the gases from wood fire. Windisch himself devised a preserving experiment during which he exposed fresh sausage for several consecutive days to fumes of formaldehyde under a moderate temperature. The sausage smelled of smoke, dried very rapidly and had an excellent keeping quality. Ströse constructed a ventilated preserving box in which, by means of the fumes of formaldehyde, meat could be easily preserved for from four to six weeks even in summer and under unfavorable weather conditions. Gottstein attempted to preserve meat with formaldehyde by covering it with gelatin and then exposing it to the fumes of formalin for a few hours. This method, however, proved to be

* According to Halliburton, the addition of 0.5 per cent. formalin stops gastric digestion absolutely and the addition of .05 per cent. delays it considerably.

impracticable, since, despite the short exposure to formalin, the meat, after lying for several months, shrunk and became as hard as stone. Likewise, an experiment of Ehrlich in preserving meat in an 8 per cent. formaldehyde solution failed. Horse meat when treated with an 8 per cent. formaldehyde solution took on an unappetizing appearance and an odor of roast goose. Beef treated with formaldehyde emitted no disagreeable odor, but became inedible after a very short treatment.

For other trade preservatives which carry high-sounding names for the purpose of concealing their simple composition, consult the investigations of Polenske in "Arbeiten aus dem Kaiserlichen Gesundheitsamte," Vols. 5, 6 and 8, and the investigations of Kämmerer in "Münchener Forschungsberichte," Vol. 2.

2.—Preservation by Heat.

The bactericide effect of high temperatures can be successfully utilized in the preservation of meat intended for long keeping only when the meat which has been subjected to heat is packed in such a manner that subsequent infection is excluded. This condition is fulfilled in the preparation of so-called corned beef, the manufacture of which is conducted on the largest scale by American and Australian firms, in order to make possible the utilization of the great quantities of meat from America and Australia in the markets of the world. Since the introduction of canned meat into Germany has been prohibited, it has been preserved on a commercial scale in this country.

For preparing corned beef, the meat is comminuted, freed from bones and fatty tissue, placed in a large pickling vat, and after it has been thoroughly salted, is boiled in large receptacles. After boiling, the meat is spread out on large tables, salted and packed in cans, and under steam pressure is packed in boxes which are at once hermetically sealed. The sealed cans are placed in boiling water for from three to six hours, according to their size, and are punctured while still hot in order to allow the escape of air or superfluous fat. The hole is then immediately closed by soldering, in order to allow the cans to be placed again for a few hours in boiling water.

Recently, mutton and pork have been preserved by the same method used in preparing corned beef and sold under the names "corned mutton" and "corned brown."

General Judgment of Canned Meat.—In canned meats we have to do with meat products in which the destruction of pathogenic organisms, which may be present in the meat, may be accomplished by means of the preserving method adopted. It is true that in the case of canned meat there can never be any certainty that the animals from which the meat was obtained were healthy. From recent reports from America, it appears that the "canners"—that is, animals which are worked up in the preparation of canned meat—belong to the poorest quality and are frequently diseased (Kühnau). Furthermore, from American reports concerning the extensive outbreaks of disease among American troops in Cuba, as a result of eating canned meat, it appears that in America, the chief exporting country of canned meat, this material is not always harmless, as prepared. The cause of the harmful property of the meat in question can not be determined from the reports. With regard to foreign canned meat, however, it should always be remembered that we are dealing with products the method of preparation of which is known in general, but can not be controlled in individual cases. In the finished product it can be determined whether the material was so well boiled before the closure of the cans that pathogenic organisms in the meat must have been destroyed. On the other hand, there is no means of determining whether chemical substances are present in the canned meat which are not at all or with difficulty destroyed by heat. The unfortunate experience which was had in feeding American troops on canned meat compels us to assume that harmful properties may be present in canned meat not only as a result of defective boiling, but also as a result of the utilization of defective material; for example, material already in process of decomposition. For this reason, according to the present status of the question, canned meat must be classed along with sausage with regard to its sanitary judgment, and must be treated in the same manner.

Injurious Canned Meat.— It is to be assumed that canned meat possesses harmful properties if the cans are swelled or soldered twice.* Likewise, it is to be assumed that the meat is harmful if the gelatin which surrounds the meat does not exhibit a firm character, but possesses a disagreable odor of putrefaction. The presence of gas in the can and the liquefaction of the gelatin indicate

* According to a circular letter of the Royal Prussian Ministries of Medical Affairs, Commerce and Interior, no violation of the law of June 25, 1887, concerning traffic in substances containing lead and zinc is found in traffic in conserve cans which are soldered with material containing lead.

putrefactive processes in the meat and an injurious character (page 756).

Dried Meat.—In South America, South Russia, Roumania and other countries, meat is preserved by drying in the air. For this purpose it is cut into narrow strips. Before being eaten the strips are softened in water. The Kalmucks dry meat by cutting it into small strips and dry it in the air or over a small smoking fire. The process of drying is of great importance in the preservation of fish. In South America meat is either dried after a previous salting ("tasajo," "charque," jerked beef) or dried beef is prepared without salt ("charque dulce"). Tasajo is quite an important article of trade. In the Saladeros of the La Plata States and in the Brazilian province Rio Grande, the meat of nearly 1,500,000 cattle is annually worked up into this product. The chief consumption of tasajo occurs in Brazil, Rio de Janiero, Cuba and the Antilles. In Brazil, tasajo is cut into pieces and cooked together with black beans to make the national dish "feijãoada." The exportation of this material to Spain, Portugal and Italy has thus far met with failure on account of the rancid taste of the dishes prepared with tasajo (Knuth).

"Carne Pura."—The attempt to introduce South American and Australian meat in powdered form—"carne pura"—has thus far met with but little success on account of the high prices of the preparation and the pungent odor which at first inheres in the meat powder. Carne pura is prepared by drying raw meat at a temperature of 40° C. The albumen thereby remains soluble (Hoffmann).

Meat Extract.—The preparation of meat extract was the first and most decidedly successful attempt to make the great meat product of America utilizable in the Old World. Previously, millions of sheep and cattle had been slaughtered merely for the wool, hides and bones. For obtaining meat extract, the meat is cut in machines and digested under high pressure. The meat broth thus obtained is passed into fat separators and thence into clarifying kettles, in which the albumen, fibrin and magnesium phosphate are separated. Hereupon the extracted mass is placed in an evaporating apparatus, from which it is drawn off by various filtering processes into large receptacles intended for shipping. The distribution of the extract into small cans suitable for retail trade takes place at the import towns.

The oldest meat extract factory (Liebig's meat extract) is in Fray-Bentos in Uruguay. This factory utilizes 400 to 500 cattle daily, producing therefrom about 1,500 kg. of extract.

Liebig's meat extract possesses the consistency of a soft extract or a thick salve. It has an acid reaction, is hygroscopic, and readily dissolves in water. The meat extract frequently contains granular material (creatin and potassium phosphate). The color, odor and taste vary according to the age and sex of the animals used in preparing the extract. According to Liebig, the meat of steers furnishes an extract of darker color and possesses a taste which, in the concentrated extract, resembles that of game, but is agreeable in dilute solution. The extract from the meat of cows is of a milder taste, lighter color and is considered better by many individuals. The meat of animals under four years of age is not suitable for the preparation of extract, for extract thus prepared is like pap and has the insipid taste of veal. Since the separation of cows and steers is not possible, the color and taste vary according as the meat of steers or cows predominates in the daily output.*

Recently, fluid extracts (Maggi, Cibils, Kemmerich and Koch) have also been placed on the market.

Nutritive Value of Meat Extract.—Meat extract is merely a condiment and possesses no nutritive value (Rubner). Frentzel, in coöperation with Toriyama, found that in dogs fed chiefly on fat and starch, a quantity of nitrogen corresponding to 60 per cent. of the extractives of the meat extract, remained in the body. These authors, however, were unable to decide whether the nitrogen was utilized as a reserve material or whether the meat extract, like gelatin, operated only in protecting protein.

3.—Preservation by Cold.

Value of Preservation by Cold.—Cold is unquestionably the best method of preserving meat. It causes no alteration in the meat either with regard to taste or nutritive value. On the other hand, it improves the quality of the meat considerably. Under the prolonged action of sarcolactic acid, meat acquires an unusually tender,

* With regard to horse meat, Liebig says the meat broth from horse meat, when steamed, forms membranes over the surface, like that of milk, which are renewed as often as removed. Moreover, the extract is thick and slimy, does not dissolve perfectly in water and always tastes of fat.

soft character, the true table maturity required by pampered palates. No hygienic scruples, as in the case of the utilization of chemical materials, can be entertained with regard to the rational application of cold, and, finally, the effectiveness of cold, as a preservative for meat, is almost unlimited. As a sample of the incomparable preserving power of cold, we may mention the fact that the Jakutes still feed their dogs on the meat of mammoths which have remained for thousands of years in the ice of the Lena.

Effect of Low Temperatures on Putrefactive Bacteria.—It must be considered as a demonstrated fact that low temperatures can not destroy the organisms of putrefaction. Pictet and Joung had perfectly negative results in exposing anthrax bacilli, *Bacillus subtilis*, and other bacteria in wooden boxes for twenty hours to a temperature of —70° C., then surrounding them with liquid carbonic acid at a temperature of —70° to —76° C., and, finally, exposing them for another twenty hours to a temperature of —76° to —130° C. by evaporation of liquid carbonic acid. Colemann and Mikendrick likewise failed to destroy bacteria in their experiment concerning the effect of cold on decomposable substances. They placed meat in hermetically sealed or at least bacteria-proof vessels (by the use of cotton plugs) in a chamber with a temperature of —56° to —63° C. for a period of at least six hours. After the meat was brought into a warm room, slight decomposition took place after ten to twelve hours and complete putrefaction after a few days.

From these and other experiments it appears that bacteria, especially putrefactive bacteria, possess a quite unusual resisting power against low temperatures. This resistance does not in any way militate against the preservative effect of cold. While it is not possible to destroy putrefactive bacteria by cold, we may still prevent their multiplication by means of low temperatures and may keep them in a dormant condition and prevent the development of their proteolytic power.

Pathogenic bacteria are as little affected by low temperatures as putrefactive bacteria. Their virulence persists unattenuated despite the long exposure to excessive cold.

Havemann investigated a large number of non-pathogenic and pathogenic bacteria with regard to their powers of growth at low temperatures and found that numerous micro-organisms, including molds, yeasts and bacteria, thrive on meat, milk and gelatin at a temperature of 7° C., such as usually prevails in good cellars and ice chests. At this temperature the growth of the majority of

organisms was only slightly checked, so that the colonies did not become visible to the naked eye until after five to seven days. Growth was completely prevented only in the case of the cholera bacillus, typhoid bacillus and the cocci of erysipelas. The vitality of these micro-organisms, however, was not destroyed by exposure for several weeks to the temperature above mentioned.

Freezing and Simple Cooling of Meat.—There are two ways of preserving meat by means of low temperatures, namely, freezing and preservation at a temperature somewhat above 0° C.

Meat may be kept indefinitely by freezing. Frozen meat, however, possesses the disadvantage that in thawing out, water vapor and putrefactive bacteria may be deposited upon the surface of the meat and thereby greatly affect its keeping property. In transoceanic traffic in meat and in provisioning garrisons, however, on account of the length of time during which the meat must be preserved, freezing can not be dispensed with, despite the disadvantages of this process. Meat-transporting steamers ply between Australia and England, carrying freezing rooms in which the meat of 4,000 cattle, 14,000 sheep and a large number of rabbits may be stored (Heiss).

Frozen Meat as an Army Supply.—The French Ministry of War instituted experiments to determine whether frozen meat could be used as an army supply. These experiments showed that frozen meat may be preserved as long as eight months without any alteration of its original character. Great difficulties, however, were encountered in transporting meat to the point of consumption. Frozen meat when surrounded by peat dust endures a railroad journey of four days even at a high external temperature. On the other hand, transportation by wagon operates unfavorably on the keeping property of the meat. For this reason it was decided to furnish only garrisons with frozen meat. It is stated that in times of peace large freezing rooms have been constructed in which hundreds of thousands of kilos of meat may be kept or used periodically and replaced.

Grassmann reports concerning investigations which were made with the meat of two steers, three hogs and three sheep, in the military freezing establishment at Thorn. The objects of these experiments were to determine the time required for the thorough freezing of slaughtered meat when hung up in the freezing room,

the length of time that frozen meat will keep, and whether any alterations occur in the meat during its preservation.

Steers were quartered, hogs halved and sheep left whole. The meat was placed in the freezing establishment on November 27. On November 28 the temperature in all the kinds of meat had sunk below 0° C., and remained at about −4° C. until August of the following year. Mutton was frozen first and beef most slowly. The following alterations were demonstrated in the meat: In February, the beef acquired a darkish surface and the pork a gray external surface. At a depth of 1 to 1½ mm. under the surface, however, the meat was juicy and of a bright red color. Moreover, a grayish-white deposit (excreted meat salts) was observed over the surface of all the meat. In March, mold fungi appeared on the beef, but they were readily removed by rubbing the meat and improving the ventilation.

In August, when the meat was taken from the freezing rooms and distributed among the troops, it was found that it not only cooked well, but that it possessed a good flavor and could not be distinguished from fresh meat. It required only half as much time as fresh meat in cooking, furnished a good broth, and proved to be especially tender and juicy in a roasted condition.

After four months the meat had lost in weight as a result of evaporation of the water to the extent of 8.8 per cent. (beef), 7.4 per cent. (pork), and 11.5 per cent. (mutton); and after nine months the meat had decreased in weight 17.8 per cent. (beef), 12.8 per cent. (pork), and 23.4 per cent. (mutton). Grassmann also observed that in thawing out considerable meat juice escaped from the meat, and this is ascribed to the fact that the cell walls may have been ruptured. No other unfavorable alterations or decrease in nutritive value took place in the frozen meat.

In the freezing rooms of the Hamburg Cold Storage Plant, experiments with frozen meat have given satisfactory results. The same may be said for the freezing rooms intended for the preservation of fish, game, fowls, eggs and milk (Kühnau).

As stated by Hofmann, freezing is not adapted to inland trade on account of the disadvantages above mentioned. For this trade the only rational method of preserving meat is to keep it at 3° to 5° C. in rooms with an average moisture content of 70 to 75 per cent. Under such conditions, however, the low temperature alone is not sufficient to prevent all decomposition of the meat. Putrefactive organisms may become located on the meat and may exhibit a slight growth even at the lower temperature. In order to destroy

the conditions for the undesirable multiplication of these organisms, it is necessary to dry the surface of the meat and to maintain it in a dry condition. On dry surfaces—and in slaughtered animals decomposition regularly begins on the surface (page 753)—all vital activity of putrefactive bacteria ceases under low external temperatures. The aim of architects and engineers should, therefore, be directed to devising cold storage establishments which produce not only cold, but dry air. Even under these conditions, the meat remains undecomposed for only a few weeks. This, however, is quite sufficient for the demands of the meat traffic.

Sources of Cold.—For producing lower temperatures we have several artificial means at our command, the simplest of which is in the form of natural or artificial ice, and the more complicated forms are found in ingeniously constructed cold air and cold vapor machines. The latter alone satisfy all the requirements of hygiene and the technique of preservation, and should, therefore, be introduced as extensively as possible. Cooling by means of ice is adapted only for household purposes, for retail dealers in large cities, and also for slaughterhouses in small cities, on account of its simplicity and cheapness. In such slaughterhouses the cost of cooling machines would be out of all proportion to the advantages derived.

(a) Refrigeration by Means of Ice.

The most primitive form of the application of cold consists in simply laying materials to be preserved upon the ice. This is also the poorest form, since the materials to be preserved are cooled only on one side, rather than on all sides, and, instead of being dry, they are artificially moistened as a result of the melting of the ice. Moreover, in the use of natural ice, there is the danger of the transmission from the ice to the meat of pathogenic bacteria the viability of which has not been destroyed by freezing. The Royal Government President at Potsdam issued a public warning against the careless use of natural ice, in which the following statements were contained:

"As a result of investigations in the Imperial Health Office, it was determined that the ice used in Berlin for domestic purposes, even when of good external appearance, often contains numerous dangerous micro-organisms quite capable of development. It is probable, therefore, that the diseases observed after the ingestion

of drinks which have been cooled by throwing in pieces of ice are not so much due to the coldness of the drink as to the pathogenic organisms which are present in the ice. The same danger may arise in the case of solid food materials which have been cooled by lying on such ice."

A better method of cooling by means of ice is found in the various devices in which the ice does not come into immediate contact with the materials to be preserved, but is separated from them by a division wall. The meat is thereby not cooled directly, but indirectly, by the surrounding air, and a moistening of the food materials by melting ice is avoided. We possess such devices on a small scale in ice chests, also on a large scale in cold storage plants in which natural ice is used. The ice is placed between two double walls on the side or in the middle of the cooling room. In the so-called Brainard system, the ice is placed upon the ceiling of the preserving room upon a corrugated metal sheet.

The following statements concerning cooling plants in which natural ice is used are taken from a description by Wittenbrink. The plant consists essentially of three rooms—an ice room, cooling room, an antechamber; the latter connects the outside world immediately with the cooling room. The cooling room and ice room are separated from each other by a division wall. The ice room lies higher than the cooling room. The cold air passes from the ice room into the cooling room through slits which may be opened or closed, as required. The cold air immediately descends to the floor, removing the heat and moisture from the meat, which hangs at about the height of a man, and again rises and escapes through a chimney or ventilator in the ceiling. The ventilation of the room is, therefore, excellent, and the inner surface of the wall, as well as the external surface of the meat, are said to be dry at all times. The plant is opened for business only twice daily, one hour in the morning and evening. The ice in the ice room keeps even through the hottest summers until winter.

Wittenbrink adds to his description the statement that the city of Waldenburg with 14,000 inhabitants has possessed a cooling plant of this sort for three years. It is said that this plant, as well as similar cold storage plants in Landeshut and Myslowitz, have proved perfectly satisfactory to the tradesmen. The meat keeps perfectly fresh for several weeks and the plant possesses the advantages of great simplicity and extraordinary cheapness of operation.

The so-called Brainard system, according to which the cold storage plant of the abattoir in Budapest is constructed, is intended

to produce the greatest possible dryness of air by stacking the ice upon a corrugated metal sheet over the cooling room. The use of corrugated metal furnishes a large surface for condensation on which the water may be precipitated and readily conducted away in the grooves.

Value of Cold Storage Plants with Natural Ice.—According to present experience, cold storage houses in which natural ice is used can not compare with artificial cold storage plants with regard to the certainty of effectiveness. Consequently they are generally too expensive, despite their apparent economy. The greater original cost of artificial cold storage plants is more than offset by the certainty of the preservation of the meat. Cold storage houses using natural ice in connection with abattoirs can be considered only as makeshifts. Various cold storage plants in which natural ice is used, as, for example, those in Schmiegel, have already been replaced by artificial cold storage establishments.

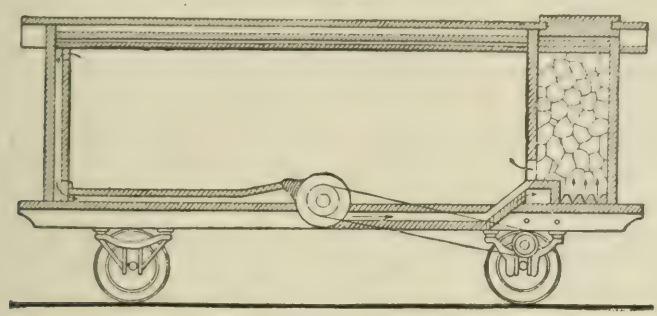
Refrigerator Cars.—Ice is used almost exclusively for cooling refrigerator cars intended for transporting meat by rail. In this case the disadvantages of the system are not so strongly felt as in stationary establishments, since the revolution of the wheels furnishes a driving power which can be readily utilized for ventilating the interior of the cars.

Various systems are in use, especially the system of Straschiripka and Tiffany, the system of Anderson, Zimmermann and Acclom, in which the air is drawn in through the ice from the outside, and the systems of Jaschka, Wickes and Schreiber, in which, by means of ventilators in the hermetically closed room, the air is kept in constant circulation between the ice room and the cooling room.

Schreiber's refrigerator cars are 7 meters long, 2 meters high and 2.33 meters wide. The double floor is provided with a layer of sawdust. The side walls consist of three layers of boards and the two inner walls are separated from each other by cattle hair and are coated with waterproof paste. The whole space is surrounded with a thick layer of felt which is held in place by a layer of galvanized iron which constitutes the inner wall of the space. The meat is hung on longitudinal bars in such a manner that the pieces do not quite come in contact with each other. Each car is provided with an ice chest with a capacity of 18 centners, which is said to be sufficient for a period of from eight to ten days. Schreiber states

that it is possible to pack 200 centners of meat in such cars. The construction of Schreiber's cars is otherwise very much like that of the cars which have been introduced by Wickes. In Wickes' cars, a larger amount of ice is required (30 to 35 centners in summer for

Fig. 254.

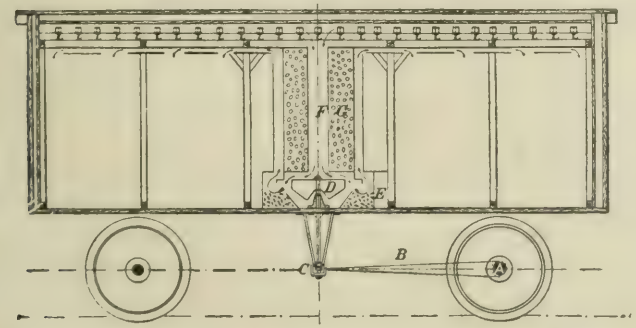


Wickes' refrigerator car.

five days). The following statements are taken from a description of Wickes' ice car :

Through a suction wall which is placed at one end of the car, the inner air of the car is drawn into a suction force fan and pressed

Fig. 255.



Refrigerating apparatus for transport cars according to Trapp.
A, axle; *B*, belt; *C*, driving pulley; *D*, ventilator; *E*, receptacle for calcium chlorid; *F*, air shaft; *G*, ice chest.

into the air distributing apparatus of the ice chest through a wooden tube which lies beneath the floor of the car. The air passes from the distributing apparatus into the ice chest, which contains 45 centners of ice. From the ice chest it passes through a series of

openings into the cooling room, from the opposite end of which it is again drawn into the suction funnel near the ceiling of the car after it has come in contact with all parts of the room. The fan is driven by power obtained from a friction wheel on the axle of the car.

Wickes' cars are used almost exclusively in America. In 1877, twelve of these cars were introduced into Austria and also proved satisfactory there. The abattoir veterinarian, Trapp, in Strasburg, has patented a new cold storage apparatus for transport cars. According to his plan, the ice chest is placed in the middle of the car, the air is drawn down over the ice by suction, but before entering the cooling room is dried by chlorid of lime. The current of air is maintained by a ventilator which is driven by a leather disk wheel on the axle of the car. While the car is in motion, the air is constantly drawn down from above by the ventilator and forced through the chest containing chlorid of lime, in which it gives up its water. Before the air enters the cooling rooms it must pass by the ice chest and thus it becomes cool and gives up its water. The air after having been thus cooled and dried passes down through the ventilator and is then distributed into the car space, where it forces the air, which has already become moister and warmer, to assume the same direction. Trapp asserts that any good freight car is adapted to the utilization of his cooling and drying apparatus, which may be improvised at any time.

(b) Cold Storage Establishments With Mechanical Refrigerating Apparatus.

It is not within the scope of a handbook on meat inspection to describe details of the various machinery which has been utilized in the production of artificial cold. These matters are of special interest to the technician and builder.* The most essential point for the sanitarian is to learn the principles upon which these artificial devices are based. With regard to the present status of the technique in the field of artificial cold storage plants, " which at the present time have assumed a great and unexpected importance

*On this subject, consult Lorenz, Neuere Kühlmaschinen, 3d ed., Munich and Leipsic, 1901 ; also Stetefeld, Die Verwendung von Kühlenmaschinen, Berlin, 1901. With regard to the operation of the machines, consult Schwartz, Maschinenkunde für den Schlachthofbetrieb, Berlin, 1901.

See also A. J. Taylor, Refrigeration, Cold Storage, etc., 1902; U. Selfi, Machinery for Refrigeration, 1900; and H. R. Leask, Refrigerating Machinery, etc., 1901. —TRANSLATOR.

such as few other fields of technique have to show," the following account is taken from a lecture of Schulze, who discussed the matter in a general way from a technical standpoint, but who referred for more accurate information to the writings and investigations of Linde, Zeuner, Pictet and Schwarz.

For the purpose of cooling meat, two cold producing machines have been most extensively utilized :

1. *The cold air or air expansion machines.* These machines are based on a law of physics that compressed air becomes considerably colder by expansion. Thus, for example, air of 2, 3 and 4 atmospheric pressure and of a temperature of 30° C. assumes temperatures of —25°, —53° and —70° C. upon expanding.

2. *Cold vapor or compression machines.* These machines utilize vaporizing substances, such as sulphurous ether, methyl ether, sulphurous acid and carbonic acid, but chiefly ammonia. They are based on the law that fluids extract heat from surrounding substances upon vaporizing. The vaporizing substances are kept in permanent circulation in a closed system of tubes. The fluid after being vaporized is again brought back in a fluid form and the latent heat thus freed is absorbed by water of ordinary temperature.

The technique of the production of cold in the vaporizing machines is described by Schultze in the following manner :

Fluid ammonia is forced under high pressure into a system of wrought iron coiled tubes, the so-called vaporizer. It is here vaporized under low pressure and thereby absorbs the latent heat necessary for vaporization from the surrounding material, air, or a fluid (salt water or chlorid of lime water). The latter is thereby greatly cooled. From the system of tubes in the vaporizer the gaseous ammonia is then drawn into a peculiarly-shaped suction and force pump, the so-called compressor. Here it is changed under pressure into a fluid condition and is then forced into a second system of coiled tubes, the condenser, in which the heat which has been developed is carried away by flowing water.

The fluid ammonia is again conducted through a connecting tube to the vaporizer and the cycle of changes begins anew. According to Edelmann, the ammonia and carbonic acid machines have proved satisfactory in Germany. However, they are not so certain in operation as the machines which utilize sulphurous acid, since they operate under a high pressure (10 to 14 and 60 to 70 atmospheres), while the pressure in the sulphurous acid machines amounts to only 2 or 3 atmospheres. Moreover, the latter machines

require no special oiling, since sulphurous acid, on account of its oily nature, furnishes sufficient lubrication for the compressors. The first sulphurous acid machines were those of Pictet. Their only disadvantage is that they require from 20 to 60 per cent. more energy than the ammonia compression machines of Linde for the production of the same degree of cold, according to the various temperatures of the cooling fluid.

Cold Air Machines.

The Bell-Coleman machine is the only one which operates according to the system of cold air machines. Air is drawn out of the cooling room and subjected to a pressure of $2\frac{1}{2}$ to $3\frac{1}{2}$ atmospheres in the compression cylinder. The air is thus greatly heated and must be cooled by injecting water. In order to dry the air again it must be passed through numerous sieve-like structures. The compressed air is cooled to a temperature of 5° C. in a system of tubes connected with the expansion cylinders. The air escapes into the cooling room from the expansion cylinders at a temperature of —40° to —50° C. through open systems of tubes furnished with ventilating holes. The Bell-Coleman cold air system has been but little used in cold storage plants in Germany. On the other hand, it is extensively utilized on meat transport ships.

Cold Vapor Machines.

Two groups of these devices may be distinguished, according to the method of using the cold which is produced by the vaporizing machines.

a. In the first group the cold is transmitted to solutions of salt or chlorid of lime, which are conducted through systems of tubes into the cooling room and thus cool the air in this room.

b. The second group cools the air directly in the coiled tubes of the vaporizer and conducts the cooled air into the cooling room.

In the vaporizing machines with the circulating salt solution, the latter, when cooled to a temperature of —8° to —10° C., is pumped into a system of iron tubes consisting of numerous coils close together and located under the ceiling of the room which is to be cooled. After the cooling effect of the salt solution has been utilized, the solution flows back to the vaporizer and there begins anew its circulation.

The cold salt water effects not only the cooling, but also a drying of the air of the room in so far as the moisture in this air is pre-

cipitated on the cold coils in the form of rime and ice. Cooling rooms constructed on this plan have been established in connection with a number of abattoirs. The great disadvantage attached to this system is that the rime and ice precipitated on the cold tubes forms a poor conductor of heat, and, therefore, hinders the cooling action of the salt solution, or entirely overcomes it. It then becomes necessary to interrupt the circulation of the salt solution and to allow the tubes to thaw out.

This difficulty is overcome by the devices classed in group *b*. According to this system, the agent which serves for transmitting the cold is entirely outside of the cooling room. The air is cooled and dried outside of the cooling room in special apparatus separated from each other and is then forced into the cooling room by means of ventilators. The great advantage of such an arrangement is quite apparent. In the first place, water which is formed by thawing and the bacteria which gain entrance to the cooling apparatus are carried outside of the cooling room and disposed of.

The cold storage systems of Pictet, Osenbrück and Linde operate according to these principles.

In the "rain-cooling" system recommended by Pictet, the salt solution falls free into a special vessel above the cooling room in the form of fine rain, through which the air which is to be cooled is driven. The cooled air is conducted through shafts in the wall from the vessel above the room in which the meat is preserved, while the warm air rises under the ceiling in the cooler. The salt water after being used is again conducted to the vaporizer. Schultze characterizes this device as very expensive.

In Osenbrück's system, the salt solution which has been cooled off in the vaporizer passes into one or more cylindrical vessels which are provided with an iron spiral stairway with perforated steps. The salt solution falls down slowly, like a cascade, while the air which is to be cooled is drawn in an opposite direction by means of a ventilator and is then conducted into the cooling room.

Linde's ice machine is distinguished by the fact that a number of rotating iron disks close together upon a common axis are dipped into the salt solution which immediately surrounds the vaporizer, while the air which is to be cooled passes over the parts of the disks which are above the solution, but which are constantly moistened. The cooled air is conducted in shafts under the floor or over the ceiling of the cold storage plant by ascending and descending tubes into horizontal distributing tubes on the ceiling of the cooling

room. It is claimed that by means of Linde's apparatus the air is renewed 8 to 10 times per hour.

The above described artificial devices for cooling meat make use of salt solutions as agents for transmitting cold produced in the vaporizers. The interpolation of these intermediary substances causes a certain amount of loss which is avoided in the Fixary system. In this system the air to be cooled is immediately passed over the coiled tubes of the vaporizer. Now, in order to make it possible to thaw out the tubes without any interruption of the cooling process, the coiled tubes are arranged in several separable systems which are inclosed separately and furnished with regulating valves. If one chamber of the system becomes covered with ice incrustations, the vaporization in it is interrupted and the ice is melted by means of warm air drawn out of the cooling house. The transmission of cold air to the cooling house is accomplished as in the systems of Osenbrück and Linde. The regulation of the valves and ventilators is, according to Schultze, a simple matter, and the production of cold by this system is greater than in those above described. "For the air is cooled off in a very energetic manner with the most complete utilization of the cold produced in the vaporizer and without any loss of energy in the intermediary substances. The dryness of the air need not be limited by the saturation point of the moisture capacity of any degree of temperature, but may fall below this. Moreover, the air may be renewed by introducing fresh outside air, since no limit is set to the movement of the air within the cooling room. This possibility of abundant ventilation is a great advantage according to the view of experts, since too much air can not easily be introduced into an abattoir.

Schultze observes also that cooling devices have been manufactured by the well-known machine manufacturer, Riedinger, of Augsburg, which operate very nearly on the same plan. In this last-named method, however, carbonic acid machines are used, and the cooling is accomplished, not immediately on the tubes of the vaporizer, but on special tubes which may be closed and which are filled with salt water.

APPENDIX.

1.—Location and Structure of Cold Storage Plants.

According to Hofmann, the following points must be considered in the structure of cold storage plants:

1. Easily accessible and practical unloading places.

2. The floors must be easily cleaned and the greatest cleanliness must prevail.

3. Abundant ventilation arranged so as to affect the whole space.

Schultze calls attention to another point which has not been properly considered in the construction of many cold storage plants: The construction must be such that the air which enters the refrigerating room, when the doors and passage ways are open, is of good quality and not laden with bad odors. The latter condition is not fulfilled when the cooling room is in immediate connection with the animal stalls. In order to secure cleanliness, Schultze recommends that the windows (with double or three-fold glass) should be capable of admitting sufficient light to enable one to detect any filth. In order to maintain the moisture content of the air in the cooling rooms at the same degree, it is desirable that freshly slaughtered meat should be allowed to cool in preliminary cooling rooms.

Moreover, in the construction of refrigerator plants, great care should be exercised that odorous building materials, such as beams saturated with tar or carbolineum, or cement material saturated with tar (for example, tar cork building brick, tar paper) should be absolutely excluded, since meat possesses the power of absorbing and retaining such odors (page 747). The failure to recognize these facts has already led to serious errors in the construction of a private refrigerator plant in Koburg, as well as in the refrigerating halls of the public abattoirs in Lübeck, Köln, Zschopau, Köslin and Riesa.

Mechanical transportation, such as was established by Moritz in the abattoir at Leipsic, must be considered the best means for carrying pieces of meat into the refrigerator room.

Over every slaughtering place there is a sliding pulley which is carried on a track which runs transversely through the hall. The forward and backward movement of the sliding pulley is produced by means of a wire cable which is attached to either end of the sliding pulley and is wound around a drum upon the ceiling of the hall. The drum is operated by a vertical shaft with conical cog wheels and a winch located at the place of slaughter. The second cable is attached to the sliding pulley in such a manner that by the aid of another windlass a hook which hangs from the body of the pulley may be let down and drawn up again. By means of this arrangement the beef animal hanging from a gambrel furnished with a long hook may be drawn up and transported wherever desired.

As soon as the cattle have been slaughtered at the different killing places, they are immediately transported to the opposite side of the slaughtering hall by means of the sliding pulley, in order to remove them from malodorous material, such as intestinal contents. They are then let down on tracks which run longitudinally along the hall, and are transported directly to the cooling room.

On the tracks are peculiarly-shaped cars provided with an arrangement for receiving the gambrels with the two halves of beef. As soon as the sliding pulley with the two halves of beef takes its position over one of the tracks, the car is pushed under the gambrel by means of a forked pole. The car receives the weight of beef upon a device intended for holding the gambrel, while the hook of the sliding pulley disengages itself by its own weight. The car is so easily moved that one person can readily propel it with its burden (two halves of beef) into the refrigerating room.

One defect which is much complained of in poorly arranged refrigerating rooms is the appearance of a mouldy odor in the refrigerated meat. Popp determined that the defective construction of the walls of the refrigerating room was the cause of this trouble. In such rooms he found that the cement wall is moist and contaminated with numerous bacteria which produce a mouldy odor in bouillon cultures and on the cement. In refrigerating rooms furnished with zinc walls but few bacteria were to be demonstrated. Popp, therefore, recommends impervious and smooth wall surfaces in order to prevent the introduction of bacteria or gases produced by them into the air of the refrigerating rooms. That air actually penetrates through walls was demonstrated by Popp in a building in which a layer of tar asphalt was placed behind the cement wall. The odor of tar appeared in the room after a few weeks. Schilling called attention to other causes of the mouldy odor in cold storage plants (introduction of freshly slaughtered meat, freshly prepared sausage, pickled meat in brine, livers and lungs). In removing the moldy odor, Schilling had excellent results from the use of formaldehyde fumes. In the refrigerating plant in Göttingen, whenever a moldy odor appeared, two Tollens' formaldehyde lamps were set in operation for a few hours, at the end of which time the air became dry and pure, without the appearance of any disagreeable effect in the meat. The preservation of pickled meat in the ventilating rooms is to be forbidden, since vaporization of the pickling fluid may produce undesirable effects upon other meat which is preserved in the refrigerating plant. Schwarz recommended for preventing this trouble the establishment of a special separate pickling room in

refrigerating plants, with which the rooms for cutting up the pickled meat may be advantageously connected.

2.—The Necessity and Advantages of Cold Storage Plants.

When we consider the tendency of meat to decompose, no further argument is necessary to show that refrigerating plants are an absolutely necessary feature of public slaughterhouses. Behrend rightfully says: "The cold storage plant forms an accumulator which eliminates the constant difference between the supply and consumption of meat." No abattoir without a cold storage plant is a principle which is recognized in a pleasing manner in the majority of the recent larger abattoirs and in some of the smaller abattoirs. Slaughterhouses of old-fashioned construction which were without the advantage of refrigerating rooms are now being furnished with modern cold storage plants. As a proof of the expediency of cold storage plants, we may mention the following results obtained from experiments which Hengst instituted in the cold storage plant of the abattoir at Leipsic, concerning the keeping power of meat in midsummer. The experiments were made on the hindquarters of cattle, calves, sheep, and hogs. It was shown that the hindquarters of cattle had lost 1.8 kg.; those of calves, 0.5; those of sheep, 0.3, and those of hogs, 0.5 kg. No further loss of weight occurred during the experiment (in the case of the calf and hog quarters after two weeks, and in the case of the cattle and sheep quarters after four weeks). With regard to the keeping power of the meat, it was demonstrated that the calf and hog quarters began to show evidence of decomposition after fourteen days and the beef quarters after about twenty-four days. No such phenomena were demonstrated, however, in the mutton quarters, even after four weeks. The process of decomposition on the cross section of the beef musculature was for the most part caused by bacilli. The decomposition products were almost odorless and were confined to the surface, while the underlying parts of the meat exhibited a perfectly normal appearance and the normal meat odor. The meat had not deteriorated in palatability as a result of standing in the cold storage plant, either in a raw, boiled, or roasted condition. It seemed, on the contrary, to have improved in this respect.

From these experiments it appears that meat preserved in cold storage plants is much improved in its keeping properties, and that the palatability and juiciness of the meat are increased rather than

diminished. With regard, however, to the loss of weight which the meat suffers during the first few days in a cold storage plant, it is scarcely greater than the loss caused by the action of the air under ordinary conditions.

XVII.

BOILING, STEAM STERILIZATION AND THE HARMLESS DISPOSAL OF MEAT.

1.—Boiling.

Effect of High Temperatures on the Harmful Properties of Meat.—Boiling is an important factor in the hygiene of meat, for it is possible by means of boiling to destroy certain injurious properties which attach to raw meat, to render dangerous meat harmless, and to make it utilizable as human food. In the discussion of the animal parasites of meat (Cysticerci and Trichina), attention has already been called to the fact that they may be destroyed with certainty by boiling. Consequently, heating the meat to a high temperature may be characterized as an effective hygienic measure for use in the case of a large number of infectious diseases.

We know from careful experiments that animal and vegetable parasites, however resistant to lower temperatures, are, in the majority of instances, readily destroyed by high temperatures. Cysticerci die at temperatures of 45° to 50° C., trichina at 69° C., and all animal parasites at the coagulation temperature of albumen. This varies for the different kinds of albumen, but is not higher in any case than 70° C. Plant parasites (pathogenic bacteria) usually require higher temperatures for their certain destruction. Spores, particularly, are able to withstand even the temperature of boiling water. Fortunately, however, in the pathogenic bacteria which occur in meat we have to deal with spores only in exceptional cases (in blackleg, malignant edema, tetanus at the point of inoculation and occasionally anthrax on the surface of meat after skinning). As a rule, pathogenic bacteria are present in meat in the vegetative form. Vegetative forms, however, without exception, die at temperatures below that of the boiling point of water.

The important hygienic effect of boiling was long since demonstrated empirically by the fact that measly and trichinous pork may

be eaten in a boiled condition without bad effects. For example, Marchi, in Florence, found only 1 *Tænia solium* among 35 tænia which he collected during a certain period, while during the same period not less than 13,000 measly hogs were imported into Florence and were consumed in that city. In southern Germany, Austria-Hungary, Italy, France and England, trichinous hogs are eaten without harmful results because they have been previously cooked. The energy and capital which are thus saved become apparent from the statement that Berlin is compelled to pay 750,000 marks yearly for protection against trichina. Berlin, however, employs only 250 trichina inspectors, while, on the other hand, in the Kingdom of Prussia there are 28,000!

Moderately high, or even high temperatures are insufficient to destroy injurious substances of a chemical nature, such as the toxic metabolic products of bacteria. Kitasato demonstrated that the metabolic products of the tetanus bacillus are changed into harmless combinations under the influence of a temperature of 65° C. for a few minutes. Similarly, Fischer and Enoch found that a certain kind of fish toxin does not withstand boiling, and Van Ermengem demonstrated that sausage poison (toxin of botulism) is rendered inert by a boiling temperature. We know from the history of meat poisoning, however, that toxic substances from the septic bacteria are, as a rule, not destroyed by boiling. Thus, in an outbreak of meat poisoning in L——, near Bregenz, Griessbeckerzell, Middelburg, Frankenhausen and Cotta, it was shown that not only boiled meat, but also the meat broth was harmful. In an outbreak of meat poisoning in Katrineholm, those persons who ate large quantities of the meat broth were most seriously affected, and, finally, in Darkehmen it was shown that only the meat broth was poisonous.

The case is similar with putrefactive bacteria. Decomposed meat is harmful even in a boiled condition, as shown by experience and experiments instituted to determine this point.

Accordingly, it would be unjustifiable to characterize boiling as a universal hygienic measure for preventing the harmful results of eating meat, as may be claimed for the boiling of water and milk for the purpose of preventing injury to health as a result of the ingestion of these drinks.

Heat Conducting Power of Meat.—In the destruction of animal parasites and bacteria by boiling, we have to consider carefully a peculiarity of meat which under certain circumstances makes

boiling a measure of problematic value. Meat is a poor conductor of heat. According to experiments conducted by Landois, meat, in the stricter sense, the musculature, is a much poorer conductor of heat than other animal tissues, which, in and of themselves, are characterized by their poor conductive power. Landois found that bones were the best conductors, the following materials being arranged in the order of their conductivity: Blood cakes, spleen, liver, cartilage, tendons, muscles, elastic ligaments, etc. According to Glage, the fat tissue is a better conductor than the musculature. It is thus explained why heat penetrates so slowly into meat that the boiling point of water is not reached in the central layers of the meat even after long continued boiling, and that finally the parts of the meat lying in contact with bones acquire higher temperatures than the parts lying more distant from the bones.

Perroncito demonstrated that in large pieces of meat, such as hams weighing 8 kg., the temperature in various central parts of the material did not reach more than 84° C., even after three hours' boiling.

Rupprecht found that boiling for 45 minutes, as is customary in lower Saxony, did not produce a higher temperature than 75° C. and this only in thin pieces of meat. In blutwurst, the temperature rose only to 66° C. during the same period; in tongue sausage and headcheese to 61.5° C.; in schwartenmagen, only to 58.75° C. Rupprecht determined the temperature of thoroughly boiled ham at 65° C., while that of pork boiled in the usual manner, together with vegetables, was the same. Meat dumplings, so much liked in Saxony, reach a temperature of not more than 58.75° C. when prepared in the usual manner, and, finally, sausages which are quickly roasted attain a temperature of only 28.75° C.

According to Küchenmeister, large pieces of so called fresh boiled pork are heated to a temperature of not more than 60° C., after the usual half-hour period of boiling—in the inner layers, not more than 55° C.—and require boiling for several hours in order to reach a temperature of 77° to 80° C.

According to a statement of Leuckart, bratwurst and cutlets attain a temperature of 62.5°; roast pork 75°, when prepared in the usual manner; and only 65° C. when prepared by the English method.

Wolffhügel and Hüppe demonstrated that the temperature in the interior of large pieces of meat never rises to 100° C., even after several hours' boiling or roasting. This temperature was reached only once, even in the superficial layers.

The following results were obtained in the experiments of Wolffhügel and Hüppe:

1. A leg of veal, weighing 14.25 kg., 73 cm. long, 43 cm. wide and 17 cm. thick, was roasted for 3½ hours in a roasting tube of a cooking machine at a temperature of 103° C. A thermometer introduced into the meat indicated temperatures of 71°, 76° and 89° C.

2. A smoked ham, of 4.5 kg. weight, 36 cm. long, 22 cm. wide and 10 cm. thick, was boiled in a cooking vessel in salt water for 4 hours at a maximum temperature of 102° C. The thermometer indicated temperatures of 75°, 77° and 78° C. in the center of the meat.

3. A piece of veal, weighing 3 kg., 25 cm. long, 13 cm. wide and 12 cm. thick, was roasted in the roasting tube of a cooking machine for 3 hours. The thermometer in the roasting tube reached 155° C. The highest temperatures in the meat were 93°, 96° and 98° C.

4. A piece of veal, weighing 3 kg., 20 cm. long, 18 cm. wide and 13 cm. thick, was roasted in the roasting tube of a cooking machine for 3 hours and showed internal temperatures of 93° and 98° C.

5. A piece of beef, weighing 3 kg., 25 cm. long, 16 cm. wide and 9 cm. thick, was placed in boiling water and boiled for 2½ hours. The thermometer in the water registered 105° C., while in the meat temperatures of 91° and 92° C. were reached.

6. A piece of beef, weighing 3 kg., 37 cm. long, 16 cm. wide and 8 cm. thick, was laid in cold water and boiled for 2½ hours. The temperatures determined in the meat were 95° and 96° C.

By the use of steam under pressure (in a Nägeli steaming vessel), Wolffhügel and Hüppe produced temperatures above 100° C. (102°–109° C.) in meat inclosed in conserve cans when the cans were not large, but held about three-quarters of a pound.

By means of a thermometer constructed for the purpose and which was introduced into the deep-lying portions of pieces of meat, Petri tested the penetration of heat into large pieces of meat and obtained the following results: In a shoulder piece weighing 4,430 gm., the thermometer introduced into the interior of the meat after 3½ hours' cooking showed that the temperature of the meat was 84° and of the bones 85.5° C. After remaining 4 hours in a roasting oven, shoulders of hogs showed temperatures of 79.5° and 91.5° C., and in the case of a ham which had likewise been roasting 4 hours, the temperatures were 62.5 and 86° C.

Hertwig instituted detailed experiments with regard to the penetration of high degrees of temperature into meat while boiling in a Becker-Ulmann boiling apparatus.*

In order to obtain results utilizable in practice, Hertwig, in his experiments, did not proceed according to the weight of the pieces of meat, but according to the thickness. He used pieces of meat of any desired length, but of the thickness of only 6 to 12 cm. The pieces of meat were laid in the hot water, which in the larger vessels showed a temperature of 94° and in the smaller 100° C., but which after receiving the meat was cooled down to 71° and 81° C. By introducing steam the former temperature was reproduced within a period of 45 to 50 minutes. After this was accomplished, the vessel was closed and was again opened after the lapse of 2 hours. The temperature of the water in the larger vessel was then 87.5° C. and in the smaller 92° C., or 7° to 8° C. lower than at first. The temperature in the interior of the pieces of meat in the larger vessel stood at 86° and in the smaller at 91.5° C. It was, therefore, only slightly lower than that of the surrounding water.

Results of Boiling Experiments.—From the experiments which have been instituted concerning the penetration of high temperatures into meat in boiling, it appears that we are able by means of rational and sufficiently prolonged boiling and roasting to produce with certainty, even in the interior of the meat, temperatures above 70° C., or above the coagulation point of albumen. By the term rational boiling in this connection is understood the use of pieces of meat not to exceed 6 to 12 cm. in thickness. The boiling period should be 2½ hours by the ordinary method of boiling, and 2 hours in the Becker-Ulmann apparatus, reckoned from the moment the water reaches the boiling point.

The temperatures thus obtained are more than sufficient to destroy cysticerci and trichina; for these parasites die at 45° to 49° C. and 60° to 70° C.

From the experiments above described, it is also apparent that by means of rational boiling we are able to produce in the interior

* The Becker-Ulmann boiling apparatus, which was used in these experiments and has been introduced into several hospitals, barracks and other institutions for cooking on a large scale, consists of a double walled wooden chest surrounded by tile, in which there are three larger and three smaller chambers, the so-called pots, for receiving the water and meat. The spaces between the walls of the chest are filled with poor heat conductors. Each chamber is furnished with a closely fitting, double-walled cover. On the floor of each chamber there is a steam pipe, by means of which the meat or the surrounding water is heated.

of the meat temperatures which lie above 85° and which are sufficient to destroy the virulence of the vegetative forms of most pathogenic bacteria, including the tubercle bacillus.

There are two defects, however, which attach to boiling, even when conducted in a rational manner; viz.: (1) the fact that the temperatures produced in the interior of the meat always vary within certain limits, and (2) the fact that we possess no easy and convenient method for determining when the temperature in the interior of the meat has risen above 85° C.

Without the aid of special apparatus we are only able to recognize that the meat has been heated to a temperature above 70° C. and we may know this, as already stated, by the discoloration of the musculature.

The defects just named may be obviated by steam sterilization.

Changes in the Weight and Composition of Meat as a Result of Boiling.—It has long been known that meat loses in weight during boiling and gives up a portion of its extractives into the boiling water. More detailed information on these points is furnished by the investigation of Ferrati and Nothwang.

Ferrati found that the loss of weight was different at different temperatures, as shown in the following table:

	Beef *Per cent.*	*Veal* *Per cent.*	*Pork* *Per cent.*
Half done (60° C.)	28.3	26.8	21.6
Well done (70° C.).....	31.3	39.2	32.0
Well done (90° C.).....	47.3	47.3	41.1

Temperatures above 100° C. caused a further loss of weight which increased with the elevation of the temperature.

Ferrati demonstrated, furthermore, that meat in *rigor mortis* suffered a greater loss of weight than meat which had not passed into rigor. The viscera were affected very differently by high temperature. At a temperature of 100° C., the heart loses most in weight (52.15 to 58.48 per cent.); next in order come the kidneys (31.47 to 37.77); liver (30.71 to 30.76); and the lungs (15.04 to 18.49 per cent.).

From the investigations of Nothwang, it appears that, in boiling and steaming fresh meat, between 50 and 60 per cent. of the extractives and about 35 per cent. of the phosphoric acid pass over into the broth. Pickled meat loses some of its extractives and anhydrous phosphoric acid in boiling and steaming, so that the

total loss in weight from pickling and boiling exceeds that which ordinarily occurs in boiling and steaming. The changes in weight shown by fresh meat in pickling, boiling or steaming are best presented in the following table:

Fresh	*Pickled*	*Boiled*	*Steamed*
100	69.9	49.5	47.4
100	67.3	50.3	43.4
100	78.1	51.5	49.3

Noack demonstrated in 19 beef animals a loss from boiling of 39.2 per cent. and in 25 hogs an average loss of 34.4 per cent.

2.—Steam Sterilization of Meat.

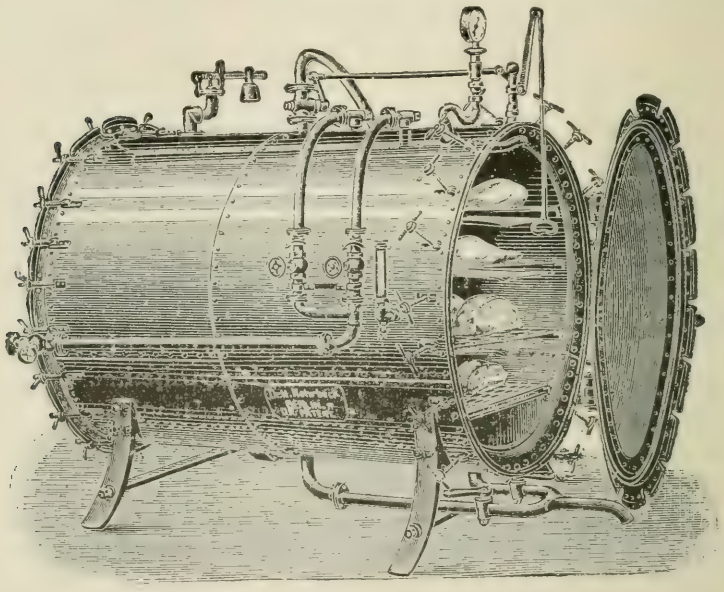
Value of the Method.—In another place, I have called attention to the fact that we have entered into a new and economically very important phase of practical meat hygiene, since Hertwig demonstrated that by the use of steam under pressure in suitable apparatus, it is possible within a comparatively short time to heat with certainty all parts of meat to a temperature of 100° C. It is thus actually possible, as Hertwig says, "to preserve as valuable food material for man large quantities of meat which have thus far gone to the knackers as practically worthless," for all objections which may be raised against the reliability of boiling infected meat fall to the ground in the use of the method in question.

Method.—Hertwig in his experiments employed a steam disinfector constructed by Rohrbeck, in which a new principle, the so-called method of pressure differences, was utilized. The apparatus possesses a device for the rapid cooling of steam, whereby the latter is condensed, and at the same time part of the latent heat of the steam set free by condensation is given off to the objects in the apparatus. By prolonged cooling, a minus pressure arises in the steam chamber which causes the gases to escape from the meat. Freshly introduced steam can thus readily enter into all parts of the meat which is to be disinfected. The disinfector consists of an iron double cylinder 2.62 meters long and 1.68 meters in diameter. The open ends may be closed air-tight by means of iron doors. Removable iron grates are arranged one above the other in the boiler, and the pieces of meat are laid upon them, side by side. Under each grate there is a roof-like zinc sheet, sloping toward either end of the apparatus and serving to receive the dripping

broth and to allow it to run into zinc troughs on the floor of the boiler.

In Berlin the apparatus is connected with the steam system of the slaughterhouse, in which the boiler, as a rule, registers a pressure of 2 to $2\frac{1}{2}$ atmospheres. In the disinfector itself, a pressure of 1 atmosphere is sufficient. In the experiments, however, the pressure was never made so great, but operations were usually carried on with $\frac{1}{2}$ or $\frac{3}{4}$ of an atmospheric pressure, the latter, however, for only a short period.

Fig. 256.



Rohrbeck's steam disinfector.

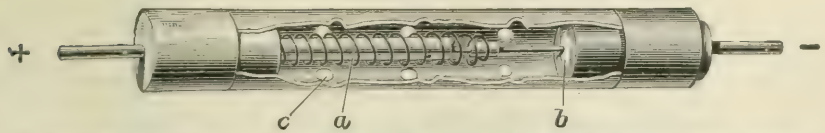
The steam enters from above and can be admitted directly from the boiler or may first be passed into the double wall (mantel) and may be conducted thence into the disinfector. By means of a special valve, it is possible to introduce the steam only into the mantel, whereby the apparatus, after the steaming operation is finished, may be operated as a dry chamber. The steam escapes from the floor of the boiler through several openings which lead into steam pipes furnished with stop cocks.

For small institutions, Rohrbeck has prepared meat sterilizers with direct heat, which cost only 600 to 1,200 marks and require but little space and may be heated by gas or coal as desired.

Duncker (Zeit. für Fleisch u. Milchhyg., Vol. 1) made the following report of Hertwig's experiments:

Before the meat was placed on the grates it was cut up in the usual manner by a butcher into pieces weighing about 3 to 6 kg., and measuring from 12 to 15 cm. The lungs, livers and other viscera were occasionally incised, but only when they were greatly enlarged and thickened as a result of pathological processes. After the meat had been laid upon the grates, a tested maximum thermometer was introduced into specially selected pieces of meat under a strict observation of all necessary precautions. Furthermore, in the center of several pieces of meat which appeared to be the most difficult ones to steam, a contact thermometer, especially constructed for these experiments, was placed, which, when a temperature of 100° C. was reached, caused a bell to ring outside of the boiler. The cords attached to the thermometers were wound with wire, which

Fig. 257.



Contact thermometer. *a*, spiral coil; *b*, alloy; *c*, apertures in the metallic case.

was introduced through the walls of the boiler and was connected with an electric battery and the numbered signal bells.*

In this way it can be instantly known when a temperature of 100° C. has been produced in the interior of the pieces of meat. In order that the highest temperature reached in the steam chamber may be controlled, another tested maximum thermometer is hung in this chamber.

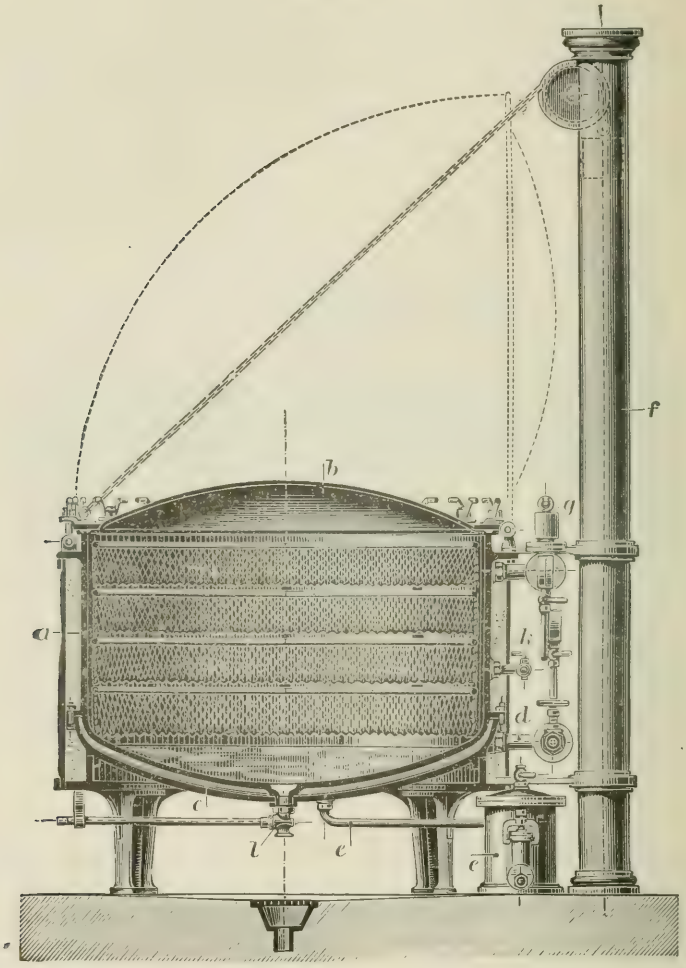
Results from Experiments.—The experiments thus conducted with regard to the penetration of heat into meat showed that uniformly lean meat is difficult to boil thoroughly. Even in larger pieces of such meat, however, a temperature of 100° C. was reached after the lapse of 2½ hours. On the other hand, such pieces as are

* The contact thermometer consists of a metal case in which one pole of the electric coil or spiral is separated from the other pole by an alloy which melts at a temperature of 100° C. (Fig. 257). As soon as this temperature is reached in the alloy plate, the poles come into contact, the electric current is closed, and the signal bell is set in action.

ordinarily found on the market require a much shorter time for thorough steaming.

On the basis of these experiments, Hertwig emphasizes the fact that in order to secure a rapid and certain heating of the meat to

Fig. 258.



Henneberg's meat steamer.

a temperature of 100° C., it is necessary that the meat be first cut into pieces 12 to 15 cm. thick and 3 to 6 kg. in weight.

It should also be observed that meat treated in a steam sterilizer is very juicy and possesses a more agreeable odor and taste

than that which has been cooked in water. The odor and taste are more like those of roasted meat, so that even beef, which, when cooked, is not so eagerly purchased as pork, finds a ready sale when steamed.

HENNEBERG'S MEAT STEAMER.—Further experiments in the direction of those by Hertwig have shown that the method of pressure difference, which is utilized in the apparatus of Rohrbeck, is not a necessary requirement for the complete and certain steaming of meat. Thorough steaming may be accomplished also in single-walled sterilizers. An apparatus of this simpler sort has been constructed by Henneberg, and on account of its low price (1,100 to 1,500 marks) has already been distributed quite widely.

CONSTRUCTION.—The apparatus consists of a boiling vessel proper (Fig. 258, *a*) which is closed above in a steam-tight manner with a cover, *b*. In order that this cover may be easily lifted, it is balanced by means of a chain, pulley and a balanced weight, which latter runs in the column, *f*. The floor of the boiling vessel is double-walled and the space between the walls, *c*, is provided with a direct steam pipe, *d*, as well as a pipe for carrying off the condensation, *e*. The rest of the apparatus consists of a safety valve, *g*, and a manometer, the removable wire basket, *i*, air cock, *k*, and discharge cock, *l*.

The apparatus is operated in the following manner: In the first place, the boiling vessel, *a*, is filled with pure water, so that the bottom is entirely covered, and then the seasoning necessary for the meat broth is added. Thereupon the meat sprinkled with salt and condiments is distributed uniformly in the wire basket, *i*. The cover, *b*, is closed tightly, and then, by opening the steam valve, *d*, the water of the boiler is brought to a boiling point. The steam thus produced arises and surrounds the meat, while at the same time the air contained in the boiling vessel escapes through the air cock, *k*. As soon as the steam begins to escape through the cock, *k*, the latter is closed, whereupon a pressure soon arises in the boiling vessel, which may be read on the manometer, and the upper limit ($\frac{3}{4}$ of an atmosphere) is regulated by the safety valve, *g*. The meat is thus exposed to the action of pure water steam under a pressure of $\frac{3}{4}$ of an atmosphere, corresponding to a temperature of 118° to 120° C. The juice which percolates out of the meat is collected in the bottom of the boiling vessel and forms, when mixed with the water and concentrated, a palatable meat broth. After the

steaming process is completed, the steam valve, *d*, is closed, and as soon as the pressure in the boiling vessel, *a*, is again down to 0, the air cock, *k*, is opened and then the cover, *b*. The meat is then removed, either from the wire baskets in separate pieces, or the baskets together with the meat are taken out of the apparatus. For this purpose the baskets are furnished with suitable handles. The bouillon is ladled out in the usual manner. It is not desirable that the broth be drawn off through the cock, *l*, since the fat would thereby be irregularly distributed in the different portions of the broth.

According to Liebe, $2\frac{1}{2}$ hours on an average is sufficient for heating even larger pieces of meat throughout to a temperature of 100° C.

Budenberg's Disinfector.—This apparatus occupies a horizontal position, and, like Rohrbeck's disinfector, is furnished with grates placed one above the other. The apparatus is so constructed that it may be used simultaneously as a destructor and meat steamer, for it makes possible the application of a steam pressure of $2\frac{1}{2}$ atmospheres. Against the use of one and the same apparatus for the destruction of material which has been absolutely excluded from the market, on the one hand, and for the steaming of food intended for human consumption, on the other hand, there are certain scruples which, although of an æsthetic nature, can not be suppressed. The utilization of separate apparatus for each of these processes is unquestionably to be preferred.

Hartmann's Meat Sterilizer.—The firm of R. A. Hartmann, in Berlin, manufactures a meat steamer which is not operated by direct boiler steam, but which changes water in the apparatus itself into steam. The impurities of boiler steam are thus prevented from coming into contact with the meat.

Careful experiments by Olt, Abel and Glage have shown that conditionally dangerous meat in pieces weighing 2 to 3 kg. and measuring 10 cm. in thickness may be thoroughly boiled and sterilized by subjection to steam for two hours in Hartmann's sterilizer under a pressure of $\frac{1}{2}$ an atmosphere.

Hartmann's meat sterilizer consists of a metal cylinder in a horizontal position, provided with a heating surface. The steaming baskets intended for receiving the meat are placed in the apparatus by hand or by a sliding grate. The lower part of the apparatus, which is intended for the introduction of the boiling water, is sepa-

rated by a transverse wall. After the apparatus has been closed by screwing on the front cover, steam from the boiler is introduced upon the heating surfaces for the purpose of producing a high temperature. The water is thereby heated and the air in the apparatus is driven out by the steam through an air cock placed in the roof of the apparatus. After the air is blown out, the air cock is closed and the meat is steamed under pressure.

According to Kühnau, boiling in the Hartmann apparatus is most successfully accomplished when the apparatus is filled with water up to $\frac{1}{2}$ the height of the lower transverse wall and when the boiler steam is introduced into the heating boxes under pressure of 4 to 5 atmospheres. The discharge of the cold air requires under these conditions 25 to 30 minutes. It may be assumed that the air is all blown out when steam escapes from the air cock in a uniformly white stream. The time required for steaming pieces of meat weighing 2 to 3 kg., measuring 10 cm. in thickness, is, on the average, 2 hours, after closing the air cock. In the case of large old cattle, it is desirable to steam the meat for $\frac{1}{4}$ hour longer, while in calves and young pigs, the period of steaming may be shortened $\frac{1}{4}$ hour. The steam pressure may be increased to $\frac{3}{4}$ of an atmosphere during the first quarter of an hour and may be maintained for the remaining $1\frac{3}{4}$ hours at $\frac{1}{2}$ an atmosphere.

Practical Rules for the Steam Sterilization of Meat.—The experiments of Abel demonstrate that pork may be, as a rule, somewhat more easily steamed than beef. On the other hand, pieces which inclose plates of bone, much fat, and which are inclosed with uninjured rind, and also pieces of poor meat, are difficult to steam. Abel, therefore, recommends that shoulder pieces, hams, very fat meat with the uninjured rind and poor muscle meat should be steamed in pieces weighing not more than 2 kg. Hams must always be split, while thin pieces of meat (flanks and rib pieces) may weigh as much as 5 kg. (Kühnau). Glage found that pieces of meat which lie upon one another and are closely pressed together do not become thoroughly steamed. The pieces of meat should, therefore, not be in contact. After the steaming process is completed, the steam should be discharged as quickly as possible, for the sooner the apparatus is opened the brighter gray the color and the more appetizing the appearance of the meat. Glage determined that the gray coloration of the meat began at the temperature of 60° C. The meat becomes light or whitish gray on the surface and is flabby and soft. The firmer consistency which indicates the

coagulation of albumen and which occurs simultaneously with the darker gray coloration of the blood and muscle pigment shows that the meat has been subjected to a temperature of 70° to 75° C. Glage characterizes such pieces of meat as "well boiled." Kühnau, on the basis of temperature determinations, gives the following criteria for insufficiently and perfectly steamed meat:

1. Cut surface, grayish-red; meat, tough; bloody meat juice; temperature, 60° to 70° C.

2. Cut surface, gray (grayish-white); meat, firm; reddish meat juice; temperature, 70° to 80° C.

3. Cut surface, gray (grayish-white); meat, tender; colorless meat juice; temperature, 80° C.

The latter meat is to be characterized as thoroughly cooked.

Loss of Weight in Meat as a Result of Steam Sterilization.—According to P. Falk, the loss of weight in beef amounts to 53.75 to 64.4 per cent. (on an average, 60 per cent.); and in pork, 37.54 to 51.05 per cent. (on an average, 46.04 per cent.). Hengst also found the loss of weight in beef as a result of sterilization to be higher than 50 per cent., while in pork it was somewhat lower, but always three-sevenths of the dressed weight. Liebe, Rieck and Noack likewise determined considerable losses of weight in sterilizing meat. They were, however, lower than those which were found by Falk and Hengst. Rieck, for example, found the average loss in 21 beef animals to be 43.1 per cent., while in 37 hogs it was only 16.7 per cent. Noack found an average loss of 44.9 per cent. in 97 cattle, 34.5 per cent. in 191 hogs, 43.4 per cent. in 21 calves and 44.5 per cent. in 30 sheep.

For the purpose of reducing this considerable loss in weight during the steam sterilization of beef, Rohrbeck proposed that sterilization be practiced with a lower pressure (from one-tenth to a maximum of one-fifth atmosphere), for beef lost only about one-third of its weight when sterilized by steam under such pressures in the Berlin Central Abattoir, under the direction of Reissmann.

3.—Harmless Disposal of Meat Absolutely Excluded From Sale.

Necessity for the Harmless Disposition of Meat Confiscated at Slaughterhouses.—The German Veterinary Council, at its fourth meeting, made the following declaration with regard to the regulation of the business of knackers: "It is most desirable

that animal cadavers be rendered harmless by the aid of chemical agents or by a high degree of heat (boiling, burning). Burying is permissible only when the method of removal just mentioned is not practicable."

The statements made regarding the cadavers of animals which have died a natural death hold true for organs and whole animals which are absolutely excluded from the market. In the discussion of the structure and internal arrangement of abattoirs, attention has already been called to the fact that more care than heretofore should be given to the harmless removal of pathologically altered organs, especially those which are affected with animal or plant parasites, and that the Saxon municipal ordinance of January 16, 1890, forbidding the throwing away and burial of tuberculous parts in dung heaps, deserves all consideration. The fact was also emphasized that in small abattoirs in which the number of condemned parts and animals is but small, the process of burning is sufficient. In all larger institutions, on the other hand, it is necessary to introduce devices by which these waste products may be not only rendered harmless, but may also be utilized as far as possible. These arrangements should be connected with abattoirs, since, according to past experience, manifold opportunity is offered on the way to the knacker for underhand dealing with highly spoiled and dangerous meat (compare page 40).

The other waste products which are found in abattoirs, the contents of the stomach and intestines, and the blood, are most suitably utilized according to the method of Ploennies. Ploennies peptonizes cattle and sheep blood, which is not utilized for food purposes, with the aid of the stomach contents of slaughtered hogs. The peptonized blood is then mixed with the dried contents of the paunch of slaughtered ruminants and in this manner a valuable feeding stuff (peptone feed) is prepared from waste products which were formerly almost or quite valueless. The intestinal contents from the stalls of the abattoir and feces containing straw are worked over by Ploennies by mixing them with unslacked lime, so as to form a firm fertilizer mass. An institution for the preparation of peptone feed has already been established at the Central Abattoir in Berlin.

The following statements may be made concerning the various methods for the harmless removal of the confiscated waste products in abattoirs.

(a) Simple Burning.

This is undoubtedly the surest means of removing all excluded animal parts, but is at the same time the most irrational, for the fuel value thus obtained in the most favorable cases from the cadavers is very slight. Simple burning can be excused only in quite small institutions in which the establishment of special apparatus would not be profitable. The utilization of special burning ovens in large abattoirs, however, is quite unsuitable. In such cases the burning of confiscated meat means an unwarrantable waste of valuable material, quite aside from the fact that considerable expense for fuel is incurred in burning the material.

Incineration may be accomplished in the fire box of a steam boiler. Feist constructed an incineration oven in an anthrax region according to the principle of lime kilns. The use of this apparatus has proved to be a valuable veterinary measure. The incineration of large animal carcasses, however, costs about 16 marks. A special burning oven for confiscated meat has been constructed by the firm of Kori in Berlin, and is characterized by an accessory fire box for drying the material to be destroyed. Kori's incinerating ovens for the destruction of confiscated meat have been established at the abattoirs in Nürnberg, Liegnitz, Stralsund and St. Petersburg. The ovens receive pieces of meat weighing 10 to 12 centners, together with the contents of stomachs and intestines, and cost from 1,500 to 2,500 marks, according to size. The incinerating oven of Schaller and Gorini and Venini are constructed in a similar manner.

According to Weyl, it is customary in England to burn animal cadavers in Tryer's Destructor. These destructors, however, are chiefly valuable for the incineration of rubbish.

(b) Chemical Treatment.

In connection with the operation of reducing animal carcasses in a purely chemical manner, mention is made in the literature of the subject of the method of Porion. He constructed a distillation apparatus, in which parts of carcasses are thrown, together with the addition of potash and iron filings for the purpose of producing dry distillation and also to obtain as final products animal charcoal and yellow prussiate of potash. This method has enjoyed, therefore, only a slight extension, since it is not very profitable.

The method of Rohkrämer is a chemical thermic one. The material to be worked over by this method is placed in sulphuric acid and heated with it for 24 hours. During this boiling, a homogeneous, more or less thick, gruel is obtained from the material of the carcasses, from which the upper layer of fat is first removed. To the remainder, steamed bone meal from which the gelatin has been removed is added in order that the superfluous sulphuric acid may be combined and the sulphuric acid content of the material increased. After a short time, the mass assumes a sufficiently thick consistency to be dried and pulverized.

Before Rohkrämer, Sombart used a still simpler method of boiling in sulphuric acid for the destruction of anthrax carcasses and thereby prepared compost from the cadavers boiled in sulphuric acid.

Boiling in sulphuric acid is a certain and profitable method, and is absolutely certain, since boiling in sulphuric acid destroys even the most resistant bacteria. The only disadvantage of this method is the danger in handling the sulphuric acid.

(c) Steam Sterilization Under High Pressure.

This method for the harmless disposal of carcasses should be preferred above all others. It not only satisfies all hygienic requirements, but renders possible the most advantageous utilization of the valuable constituents of the animal body. By the use of steam under pressure, temperatures may be produced, which, on the one hand, far exceed 100° C. (up to 150° C.) and destroy all organic life, even the most resistant bacterial spores, and, on the other hand, dissolve the organic structures of tissues to such an extent that the component elements of the latter, especially albuminates, salts and substances which yield gelatin and fat, are separated from one another.

The principle of steam sterilization under high pressure is utilized in practice in various forms.

1. Treatment of Carcasses in So-called Digestors.—Digestors are iron cylinders, several meters in height and about one meter in diameter. They are constructed according to the principle of Papin's Digestor and resemble gelatine steamers, which have long been in use in bone gelatine factories. These cylinders receive the parts of the carcass to be destroyed after the latter have been previously comminuted. Thereupon this material is subjected to live steam

under a pressure of $2\frac{1}{2}$ to 3 atmospheres. The statements concerning the length of the period of steaming vary: Reclam asserts that 2 to 3 hours are sufficient. In Vienna also the period of steaming under pressure is, according to Toscano, only 3 hours. In the Berlin Fiscal Knackers' Establishment, on the other hand, the parts of meat to be destroyed are left in the digestor for 8 to 10 hours under steam pressure.

After the material has been thoroughly steamed, the fat and gelatin water are drawn off. The fat is conducted into clarifying pans, where it is purified by chemical and mechanical means in order that it may be utilized as machine oil and in the manufacture of soap. The gelatin water is likewise clarified and then condensed. According to Reclam, gelatin may be used in the manufacture of printers' rollers and for a finishing material in cloth mills. The remainder (parts of meat and bones freed from fat and gelatin) are placed in a kiln for drying and are pulverized by means of a grinding-and-sifting apparatus.* The latter may be used not only as a fertilizer, but also for feeding hogs and fish. The most valuable product obtained from this manipulation of carcasses is the fat. This may have a value of 40 marks or more per 100 kg. On the other hand, the gelatin and animal meal are in part either absolutely unsaleable or can be sold only with difficulty (Resow). If, as is generally assumed, animal meal proves to be valuable in the future as a feeding stuff, the profit from the manipulation of carcasses will be considerably greater than heretofore.

Reclam states that in Leipsic the artificial fertilizer establishment provided with digestors can profitably haul away the carcasses and pay a small sum for them. This sum amounts to 15 marks for large animals in a poor condition and 55 marks for fat animals.

2. The Copenhagen Method of Destruction.—In Copenhagen, there is a special institution established for destroying and utilizing meat which has been confiscated in abattoirs. The meat to be destroyed is placed in the upper room of the destruction establishment, which is constructed at the level of the upper edge of the cylindrical destructors. In this room the necessary comminution is performed, whereupon the meat is thrown into the destructors and is steamed under a pressure of 3 to 5 atmos-

* Large quantities of this material are annually sold in this country. The poultry industry alone consumes hundreds of thousands of pounds.—Covert.

pheres for 4 or 5 hours with periodical discharge of the steam. After this operation is completed, the fluid which is collected in the destructors is drawn into a large cylindrical boiler occupying a vertical position and constructed with a conical bottom in such a manner that the cylindrical part lies in the upper room, while the conical bottom projects into the lower room. After the fluid has settled, the "soup" is drawn off through a cock in the bottom and the fat remaining behind is boiled with water. After the fat has been purified in this manner, it is drawn off into vessels and thus furnishes a finished trade product, utilizable for technical purposes. The steam obtained by blowing off the destructors and from boiling the meat is conducted into a worm in a receptacle filled with water. The steam is thus condensed and the fluid is carried off into the sewer. By this means warm water is obtained for bathing, washing and filling the vessels, and at the same time bad odors from the boiling processes are avoided.

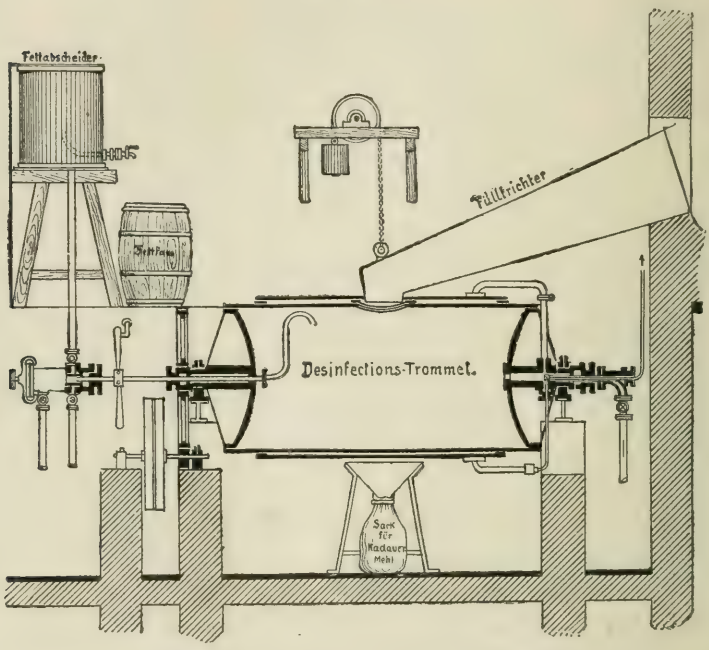
3. The Method of Podewils.—This method, which has been in practical use for 18 years in Augsburg, consists of cutting up the animal carcasses into large pieces and placing them in a heated rotating drum. This drum operates as a high-pressure steamer, drying apparatus and pulverizing machine. The parts of carcasses are steamed under a pressure of 5 to 6 atmospheres (corresponding to a temperature of 150° to 160° C.), and after the fat has been drawn off, together with the so-called gelatin broth, it is dried by steam heat and simultaneously pulverized. The extraction of the fat from the carcasses is promoted by washing the cadaveric mass after a period of 2 hours' steaming by means of hot gelatin broth obtained from a previous operation of the apparatus, and this process is continued until the whole apparatus is filled up to the level of the manhole. By means of a valve located near the manhole and a connecting pipe, the fat is then forced out of the apparatus in a pure condition. After the separation of the fat, the gelatin broth is also dried. The whole process takes place without contact with the air and the fumes which are developed are condensed in water, while the gases which can not be condensed are passed under fire. The parts of carcasses introduced into the apparatus leave it in the form of a pulverizable, dry animal meal.

The advantages of this method, according to a statement of the inventor, consist (1) in the complete absence of odors; (2) in a favorable action of the rotation of the drum upon the comminution and desiccation of the material; and (3) in the simultane-

ous desiccation of the so-called gelatine water, whereby all danger associated with the fluid is avoided.

The method of Podewils has been introduced into the abattoirs at Barmen, Kattowitz and Beuthen in Silesia, and Aarhus and Odense in Denmark. It has also been utilized for a long time in

FIG. 259.



Podewils' apparatus for reducing carcasses.

various knackers' establishments (Augsburg, Munich, Graz, Hamburg, Friedberg in Hessen, Dresden, Cannstatt, Hatzfeld, near Barmen, and Lausanne in Switzerland.

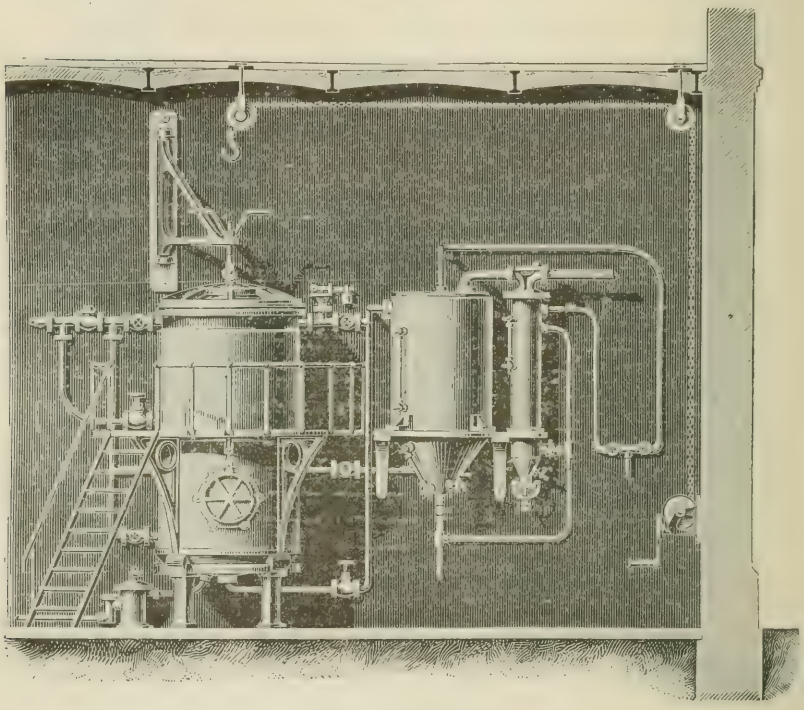
PROFIT FROM THE APPLICATION OF PODEWILS' METHOD.—In judging the profit to be derived from the application of Podewils' method for the treatment of carcasses, the following table, published by Vollers, may be of interest:

Horses and Colts	Cattle	Calves and Sheep	Sheep Lambs Goats Kids	Hogs	Dogs Cats Rabbits etc.	Fowls	Abattoir Meat	Total	Period for Removing Fat	Drying Period	Total Time	Fat Obtained	Fertilizer Obtained
Kg.	*Kg.*	*Kg.*	*Kg.*	*Kg.*	*Kg.*	*Kg.*	*Kg.*	*Kg.*	*Hours*	*Hours*	*Hours*	*Kg.*	*Kg.*
800	1,000	100	25	75	125	200	600	2,925	4	11¾	15¼	180	744
400	2,000	—	—	200	167	—	150	2,914	4	9½	13½	175	750
900	1,050	—	—	250	110	—	500	2,610	4¼	10	14¼	209	656
850	900	—	—	250	250	—	665	2,915	4½	10	14½	175	813
650	1,250	—	—	—	430	—	600	2,930	4	11½	15½	160	770
800	1,000	—	25	—	252	—	600	2,677	4	11	15	150	705
1,350	—	—	—	—	—	—	1,000	2,359	4	10	14	135	670
900	500	150	—	300	320	9	200	2,379	4	9	13	140	700
—	2,000	—	—	100	225	—	500	2,825	4	9½	13½	100	665
—	1,500	—	—	500	40	—	650	2,690	4	9	13	300	689
2,000	—	—	—	—	400	150	350	2,900	4	8¾	12¾	150	786
400	1,500	—	—	400	60	—	500	2,760	4	10	14	375	697
600	800	—	—	300	100	—	600	2,400	4	10	14	250	653
990	1,000	150	—	100	180	—	400	2,730	4	9½	13½	200	822
900	1,250	—	—	—	185	7.5	300	2,642.5	4	10	14	120	800
								40,656.5				2,810	10,920

The price obtained for the fat is 40 to 42 marks per double centner, and for the fertilizer 11 to 12 marks.

In 1894, a total of 569,565 kg. of raw material was utilized. The profit amounted to 53,350 kg., or 9.04 per cent. fat, with a value of about 23,474 marks, and 139,456 kg., or 24.5 per cent. of the mass in fertilizer, with a value of 16,734 marks. The fat obtained by Podewils' method, as in all other methods, naturally varies according to the fat content of the material used.

Fig. 260.



Kafill disinfector.

4. De la Croix's System, named for the Veterinarian de la Croix, Director of the Abattoir in Antwerp.—The apparatus constructed by this veterinarian has been introduced also in Germany through the efforts of Lydtin and is now manufactured by the firm of Rietschel & Henneberg in Berlin under the name "Kafill Disinfector."

The apparatus consists of three cylinders (Fig. 260). The largest cylinder or disinfector proper (the first cylinder on the left

in the figure) is furnished with a steam chest; that is, it is constructed with double walls and possesses at the top an easily removable cover for introducing the carcasses, etc. The second cylinder is a receiver, in which all of the fluid portions, fat and gelatin broth extracted from the carcasses are collected, while the third and smallest cylinder serves as a condenser for the fumes and gases which are drawn off from the other cylinders. The sterilizer is connected with a steam boiler by means of a special pipe and is heated by one pipe from the steam boiler, while another pipe leads to the inside of the sterilizer by means of three branches which may be closed with valves.

Other pipes furnished with valves branch off from the highest and lowest point of the disinfector. They unite and pass to the receiver in the form of curved pipe. The connection of the latter with the condenser consists in a transfer pipe which can not be closed, the end of which is bent in the form of a semicircle, is perforated with small holes and penetrates into the water in the condenser. From the upper end of the condenser, a pipe which is kept constantly open leads to the fire box.

The remainder of the construction of the receiver and condenser is alike. It consists of sprays, gauges, stop cocks and discharge valves. Moreover, the receiver is provided with special stop cocks.

After the apparatus is filled in the proper manner, the cover is closed steam-tight and the apparatus is heated by opening a valve in the steam chest. The dry heat in the interior of the disinfector is thus communicated to the layers of meat, so that the steam which operates on them later finds a material which is already hot and produces its full effect without condensing. After this preliminary warming process has been carried on for thirty minutes, the true disinfection process is begun by introducing steam into the disinfection cylinder. The steam is now under the full pressure of the steam boiler and the material in the disinfector is subjected to the action of the steam for six to twelve hours.

5. Hartmann's Extraction Apparatus.—This apparatus for the destruction of carcasses is constructed like the Kafill Disinfector. This new apparatus, like the Kafill Disinfector, consists of three vessels connected with one another by pipes; viz.: (1) a vertical sterilizer which serves at the same time as a fat extractor; (2) a horizontal cylinder for the reception and evaporation of the gelatin

water; (3) a rectangular wrought-iron condenser for receiving the fumes from the other two vessels.

Furthermore, the structure consists of a drying apparatus with rotating catchers and two steam-heated iron shoulders, as well as a Gruson Excelsior Mill.

While in the Kafill Disinfector destruction is brought about by direct steam from the boiler after the preliminary heating of the meat, the material in Hartmann's apparatus is steamed in its own water, as in an autoclave, for the purpose of saving expense. It was found, however, that steaming the material in its own water required a longer time, and was, therefore, more expensive than steaming with direct steam from the boiler. For this reason Hartmann has abandoned his new method and boils the material with direct steaming during the first half of the boiling period.

The time required by this method, which, like that of the Kafill Disinfector, is odorless, is, according to Colberg, from 6 to 8 hours. After the process is ended, the clarified fat may be completely drawn off from the first cylinder. The gelatin water in the second cylinder is then steamed until a thick fluid mass remains. The steaming process lasts "several hours" and takes place during sterilization and also during the drying and pulverization of the residue of the meat and bones.

According to a statement of the manufacturer, Hartmann's destroying apparatus has been introduced into 12 institutions during the last two years (1900–1901).

The dry fertilizer powder amounts to about 12 per cent. of the raw material. The fat obtained in 24 experiments amounted to only 5.3 per cent., but, according to Colberg, may be estimated at 8 per cent. on an average. The amount of gelatin obtained was also 8 per cent. In Magdeburg, 36 marks was the price paid for fat per double centner and 11 marks for the gelatin. The value of a double centner of fertilizer was estimated at 8.5 marks.

6. Otte's Apparatus.—This apparatus is said to accomplish steaming, drying and pulverizing in one apparatus, as in Podewils' method. The whole apparatus consists, likewise, of three vessels, a disinfector, receiver and gelatin steamer. A simple digestor is also used as an accessory apparatus for receiving whole carcasses.

The most important part of the apparatus, the disinfector, is a double walled stationary cylinder, within which a perforated drum revolves which serves to receive dissected carcasses, parts of meat and other animal waste products. Inside the mantle of the station-

ary cylinder are peculiarly arranged shovels and brushes, which, by constant motion and turning, hasten the desiccation of the animal meal and serve to empty the apparatus completely after the desiccation is accomplished.

In order to operate the apparatus, the mantle of the cylinder is first heated by steam under a pressure of from 4 to 6 atmospheres and the drum is turned. After a short time the steam is admitted into the interior of the cylinder, whereby the cooking process is begun. In the meantime the revolution of the cylinder is continued for about one hour. The drum is then allowed to remain quiet until the extraction of the fat and gelatin is completed, after about 3 hours. The fluids which drip through the perforated drum are forced into the receiver. As soon as the dripping ceases, the outer mantle of the cylinder is heated for the purpose of drying the extracted cadaveric masses. The perforated drum is also moved backward and forward. It is said that after about five hours the whole contents of the drum become dry and may be ground through the perforations by means of edge rollers.

It should also be noted that there is a steaming vessel in use for the technical utilization of confiscated meat in the abattoir at Zwickau, and Rohrbeck and Budenberg recommended their disinfectors also for the harmless destruction of animal carcasses.

Concluding Remarks.

Veterinarians will deserve the great gratitude of stock raisers if they earnestly strive to introduce devices everywhere, but chiefly in abattoirs, whereby not only a certain destruction of whole animals and parts excluded from consumption, but also an advantageous technical utilization of this material may be accomplished. By this means a considerable portion of the national wealth will be saved instead of wasted and the great loss which agriculture suffers through the condemnation of whole animals or parts of animals will be diminished.

Appendix.

Enforcement of Section 21 of the Imperial Meat Inspection Law.

By an Imperial decree of February 16, 1902, it was ordered that Section 21 of the Meat Inspection Law should go into force October

1, 1902. This paragraph forbids the utilization of materials and also methods of procedure in the commercial preparation of meat, which may lend the products an injurious property or which are calculated to conceal harmful or inferior quality. In the proclamation of the Imperial Chancellor of February 18, 1902, the materials the utilization of which is forbidden from and after October 1, 1902, are named.

The decree of February 16, 1902, with regard to the partial enforcement of the law concerning the inspection of food animals and meat of June 3, 1900 :

We, Wilhelm, by grace of God German Emperor, King of Prussia, etc., in the name of the Emperor and with the consent of the Federal Council, decree on the basis of Section 30, line 2, of the law concerning the inspection of food animals and meat, of June 3, 1900, the following :

Section 21 of the law concerning the inspection of food animals and meat of June 3, 1900, shall go into force October 1, 1902. Simultaneously, the provisions of Section 26, No. 1, Section 27, No. 1., and Sections 28 and 29, shall go into force so far as they concern violations of Section 21, paragraphs 1 and 2, of a prohibition issued on the basis of Section 21, paragraph 3.

WILHELM,
Count von Posadowsky.

The proclamation of the Imperial Chancellor reads as follows :

Proclamation concerning injurious and deceptive additions to meat and its products, February 18, 1902.

On the basis of Section 21 of the law concerning the inspection of food animals and meat of June 3, 1900, the Federal Council has rendered the following decisions :

The provisions of Section 21, paragraph 1, of the law apply to the following materials, as well as to preparations containing such materials :

Boric acid and its salts ; formaldehyde ; hydroxids and carbonates of alkalies and alkaline earths ; sulphurous acid and its salts as well as hyposulphites ; fluoric acid and its salts ; salicylic acid and its combinations ; salts of hydrochloric acid.

This applies also to coloring materials of all kinds, except that it shall not be construed to mean the prohibition of the utilization of a yellow coloration of oleomargarine and the coloration of sausage casings in so far as this utilization does not violate other provisions.

COUNT VON POSADOWSKY.

Berlin, February 18, 1902.

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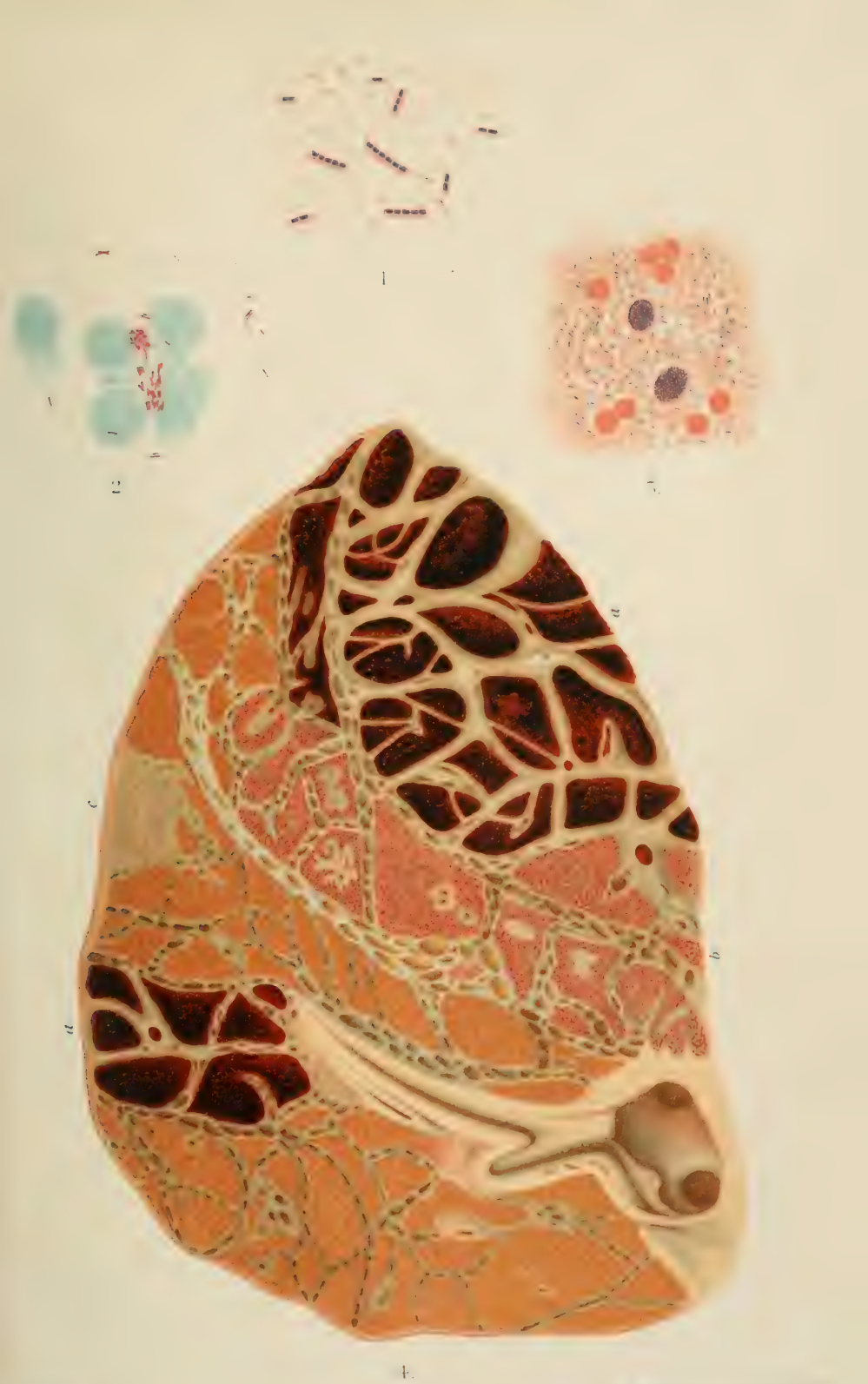
COLORED PLATE.

Fig. 1. Anthrax Bacilli.—Double stain according to Klett. × 500 diameters.

Fig. 2. Tubercle Bacilli.—Double stain according to Ziehl-Gabbet. × 500 diameters.

Fig. 3. Swine Erysipelas Bacilli.—Gram method, subsequently stained with eosin. × 500 diameters.

Fig. 4. Pleuro-pneumonia.—*a*, fresh focus of inflammation; *b*, older foci; *c*, necrotic focus (without sequestration as yet). Thrombi are shown in the blood and lymph vessels in the much thickened interlobular tissue of the freshly inflamed foci.



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